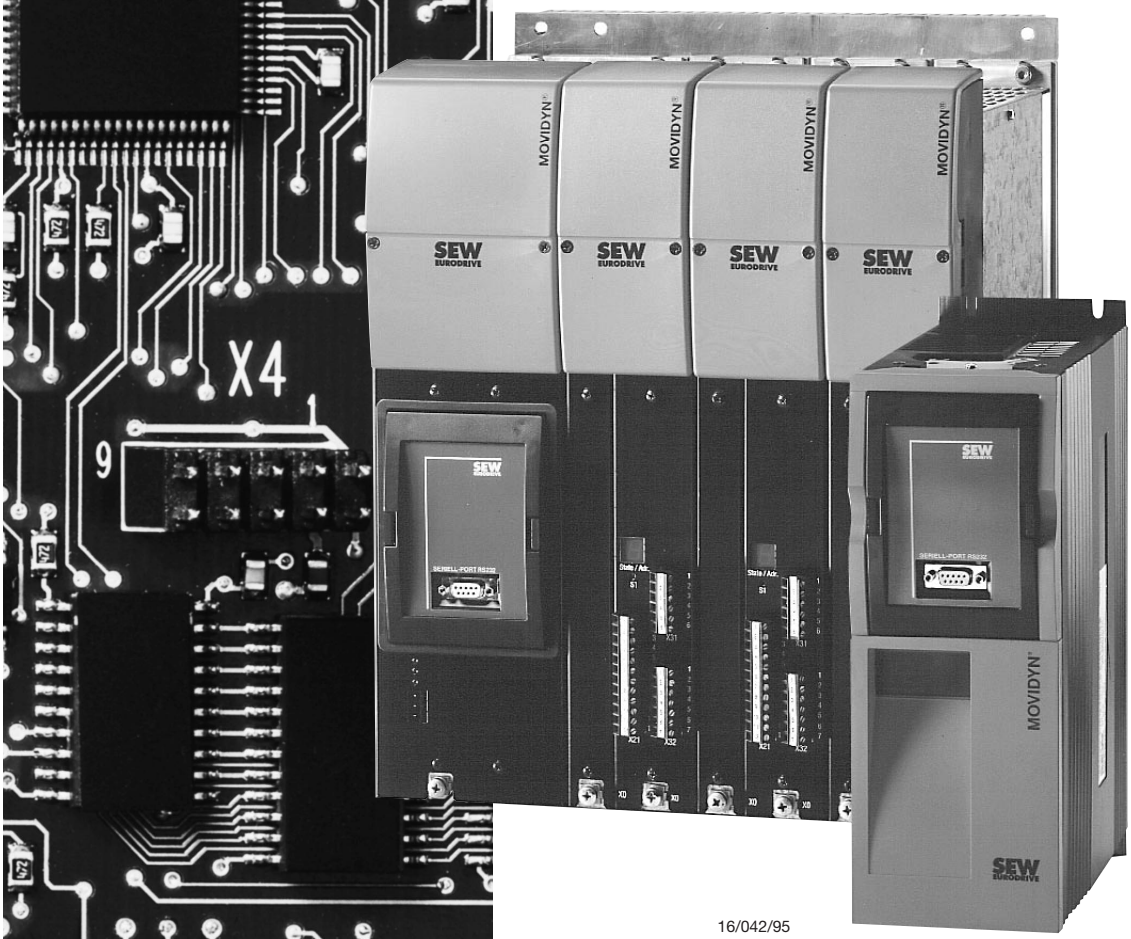
MOVIDYN®
Servo Controller

Manual

Single-Axis Positioning Control APA12 / API12

Edition 01/97



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SEW EURODRIVE

Illustration APA 12/API 12

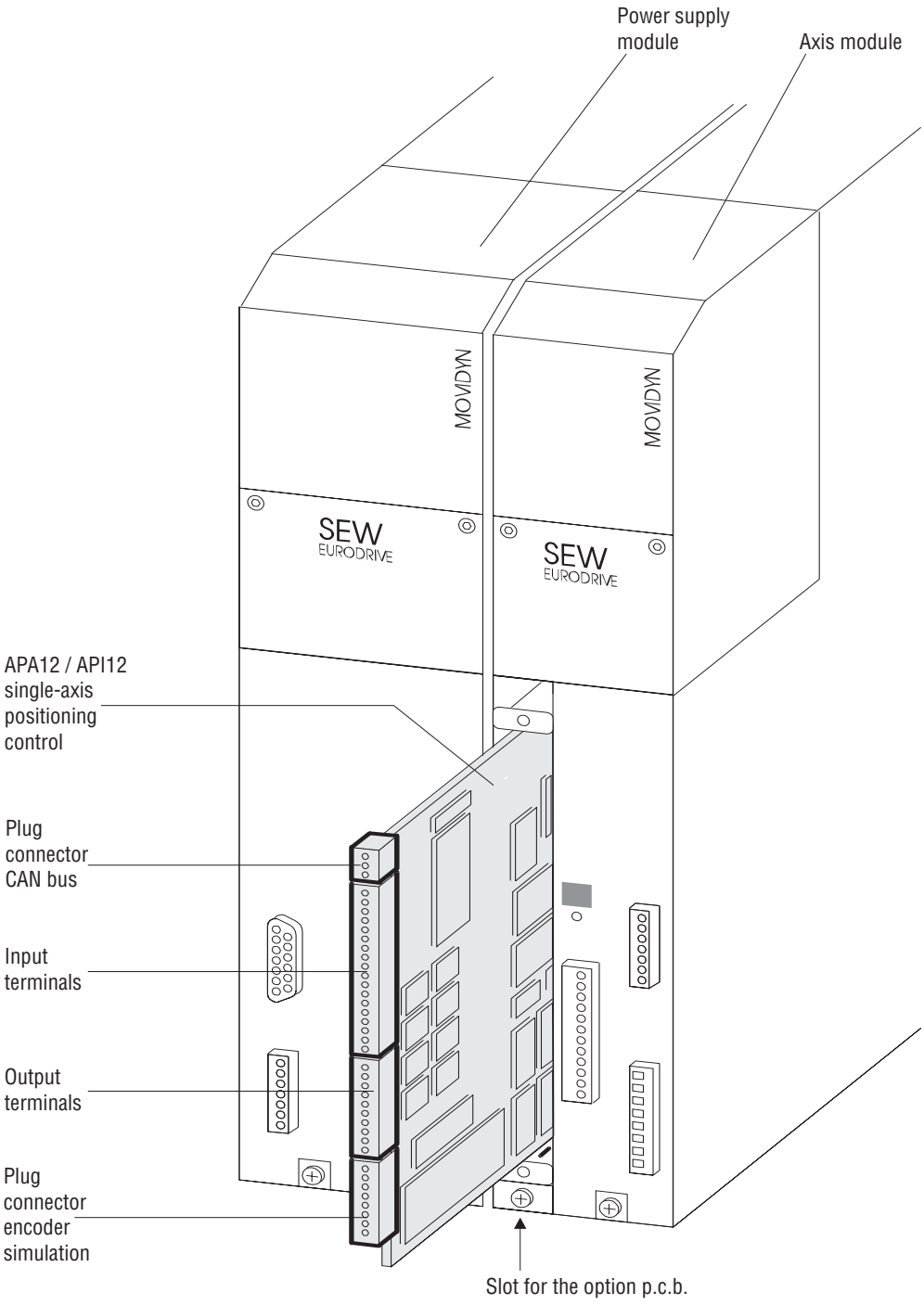

Fig.1: View of the APA12/API12 option pcb installation 00004AEN

On compact servo controllers the slot for the option pcb is on the left-hand side, like on the axis module.

- **Please read this user manual carefully and thoroughly before installing and commissioning the APA12/API 12 single-axis positioning control option of the MOVIDYN® Servo Controller.**

  It is assumed that engineers performing the work described in this user manual are familiar with the MOVIDYN® Servo Controllers for DFY permanent-field synchronous motors (operating instructions) as well as the MD_SHELL user interface (user manual) and their operation.

- **Safety Notices**

  Strictly follow all warnings, precautions and safety notices contained in this manual.
  Conventions used in this manual

Electrical hazard, e.g. when working on live equipment

Mechanical hazard, e.g. when working on hoists

Important note for safe and trouble-free operation of the driven machine/system, e.g. presettings prior to commissioning. Failure to observe these notes may result in serious risk of injury to yourself and others and damage to the equipment.

- **Cross-references are identified by a →**

  – (→ MD_SHELL) means read up on this topic in the MD_SHELL manual or you will find more detailed information there.

  – (→ section x.x.) means refer to section x.x. of this manual for additional information about this topic.

- **Representation of menu items**

  Menu options etc of the MD_POS user interface which are referenced in the text are enclosed in brackets [ ].

- Each unit is manufactured and tested by SEW EURODRIVE in conformance with the applicable technical documentation.

  In the interest of technical progress, technical data and designs as well as the user interface described herein are subject to change without notice.

  Follow the instructions and notes contained in this manual to ensure trouble-free equipment performance and best results.

  Failure to observe this may result in a refusal of any subsequent warranty claim.
  This manual also contains important service information. We therefore advise keeping it near the unit.

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- **The positioning module may only be installed by qualified and trained electrical personnel in conformance with the applicable accident prevention regulations and installation instructions (e.g. EN 60204) and as shown in the connection diagram.**
- **With their cover removed the units have enclosure type IP 00 with dangerous voltages present at some places. After commissioning, i.e. when in operation, the cover must be replaced to provide protection.**
- **Protective measures and equipment must be chosen according to the applicable standards (e.g. EN 60 204).**
- **When installing and commissioning the unit, strictly observe the applicable instructions.**

1 Installation

1.1 Mechanical and electrical installation

Installing the option p.c.b.

The APA12/API 12 single-axis positioning module is plugged into the option p.c.b. slot of the MOVIDYN® axis module (see Fig. 2).

Before starting

- Make sure that the power supply and axis module(s) of the MOVIDYN® Servo Controller have been properly installed and commissioned (see the MOVIDYN® Servo Controller Operating Instructions, sections 1 and 2).

Plugging in the APA12/API12 positioning module

- Disconnect the MOVIDYN® Servo Controller from the supply (de-energize). Also disconnect any separate-source voltages that may be applied (like an external 24 V_{DC} supply).
- Remove the cover from the option p.c.b. slot (2 screws for type MAS...).

Care must be taken to prevent any damage to the p.c.b. as a result of electrostatic discharge (e.g. improper handling by commissioning personnel).

- Before touching the p.c.b. make sure you have taken appropriate e.s.d. measures (wrist strap, conductive shoes, etc.).
- Position the p.c.b in the guide rails of the option slot with the backplane connector to the rear. Make sure the p.c.b. sits properly in the rear guide rails.
- Press the backplane connector of the p.c.b. into the socket in the axis module housing. The p.c.b. sockets must be flush with the axis module cover.
- Cover the p.c.b. slot with the cover supplied with the p.c.b. and screw tight (MAS... only).

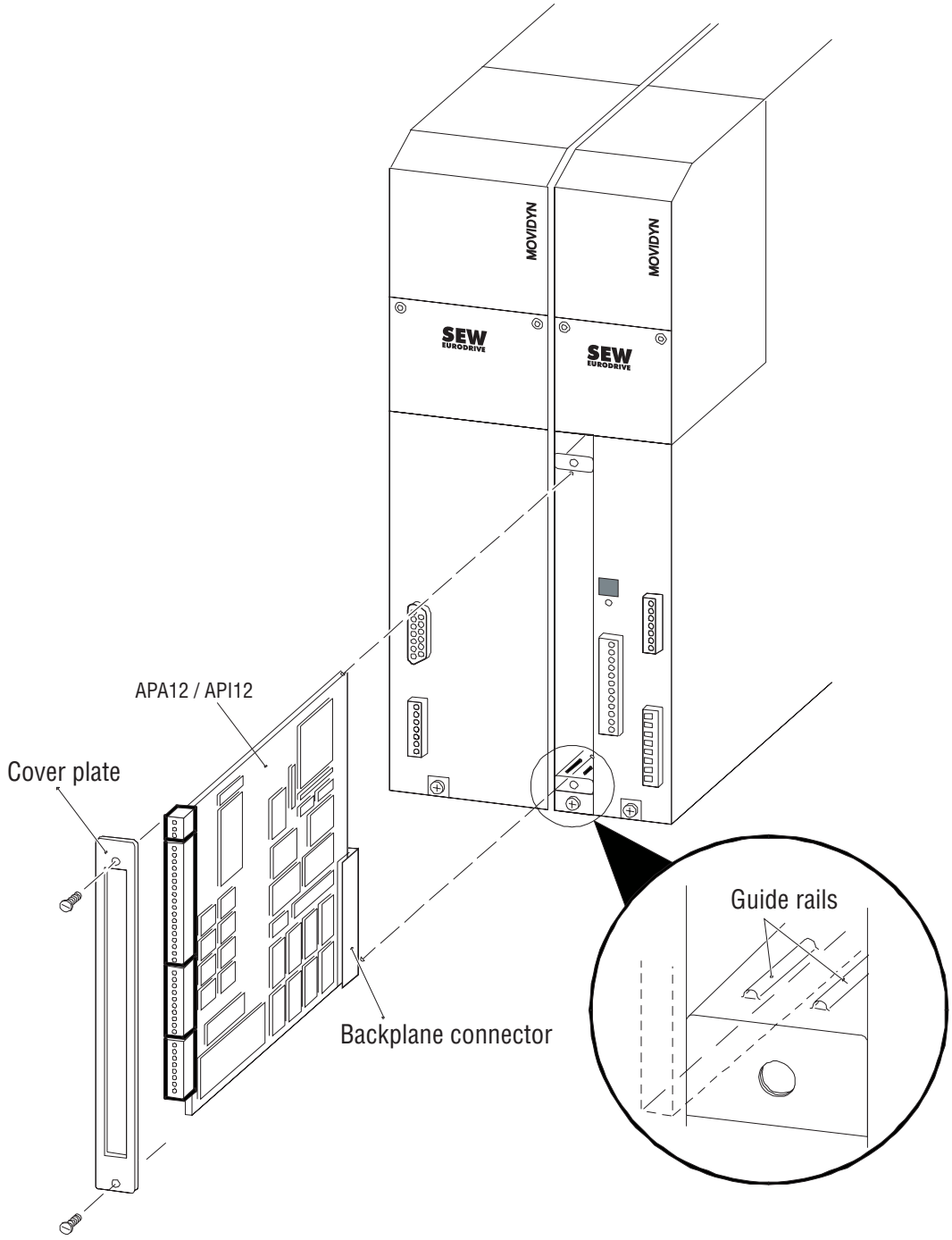

Fig.2: Installation of the APA 12 / API 12 single-axis positioning control option

Connecting the leads

The single-axis positioning p.c.b. has pluggable terminals. The plugs are supplied with the p.c.b. and come plugged into the sockets.

- Encoder connection

The API 12 can be operated with the encoder simulation provided by the axis module or with an external encoder for sensing the actual position, whereas the APA 12 may only be operated together with an external encoder.

The encoder simulation provides track signals A, $\overline{A}$, B, $\overline{B}$ and the zero pulse C, $\overline{C}$. The signals are output in conformance with the RS-422 standard. They are generated from the resolver signals of the motor connected at the axis module. A resolution of 1024 pulses/revolution of the motor is provided. This resolution cannot be changed.

If an external encoder is used, the encoder must have its own voltage supply for the encoder electronics. The voltage source of the API 12 is +15V (-0.5/+2V) with a maximum ampacity of 240 mA.

An external encoder for the API 12 should have the complementary signals A, $\overline{A}$, B, $\overline{B}$ and the zero pulse output C, $\overline{C}$ pursuant to RS-422 specification. However, it is also possible to connect unipolar encoders with signals A, B, C. The zero pulse of the encoder is crucial for determining the home position when a reference travel is performed.

The external encoder for the APA 12 must supply the data + and data - signals. From the APA 12 the external encoder receives the pulse + and pulse - signals.

The encoder simulation of the axis module is factory-connected to the positioning if the API 12 is supplied with the axis module. If the API 12 is ordered and supplied separately, the necessary connections are enclosed in the package.

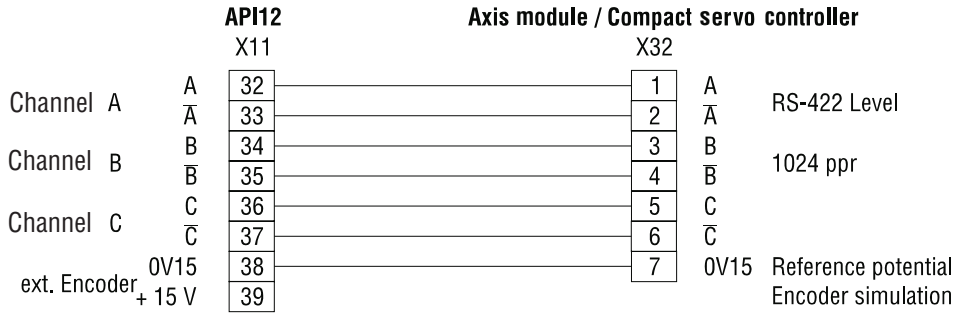

Figure 3: Connection of the encoder simulation for the API 12

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Caution
If the encoder simulation/the encoder and the APA 12/API 12 are not connected correctly, the axis may start moving during commissioning without any form of control!

- Establish all electrical connections as shown in the wiring diagrams. Also see the notes below, the illustration “Terminal assignment” and the table “Terminal functions”.
  - Connect all conductors to the respective terminals of the plug. Make sure that all terminals are screwed tight.
  - Plug all plugs into the correct sockets.
  - **Run signal leads separate from power leads.**

Wiring examples: see section 8.1

Installing the encoder

The absolute encoder is connected to terminals X11/32-33 (pulses), X11/34-35 (data) and X11/38-39 (power supply).

Recommended cable: 6 x 0.25 mm² twisted pair, shielded
39 Ω / km line resistance
120 Ω surge resistance

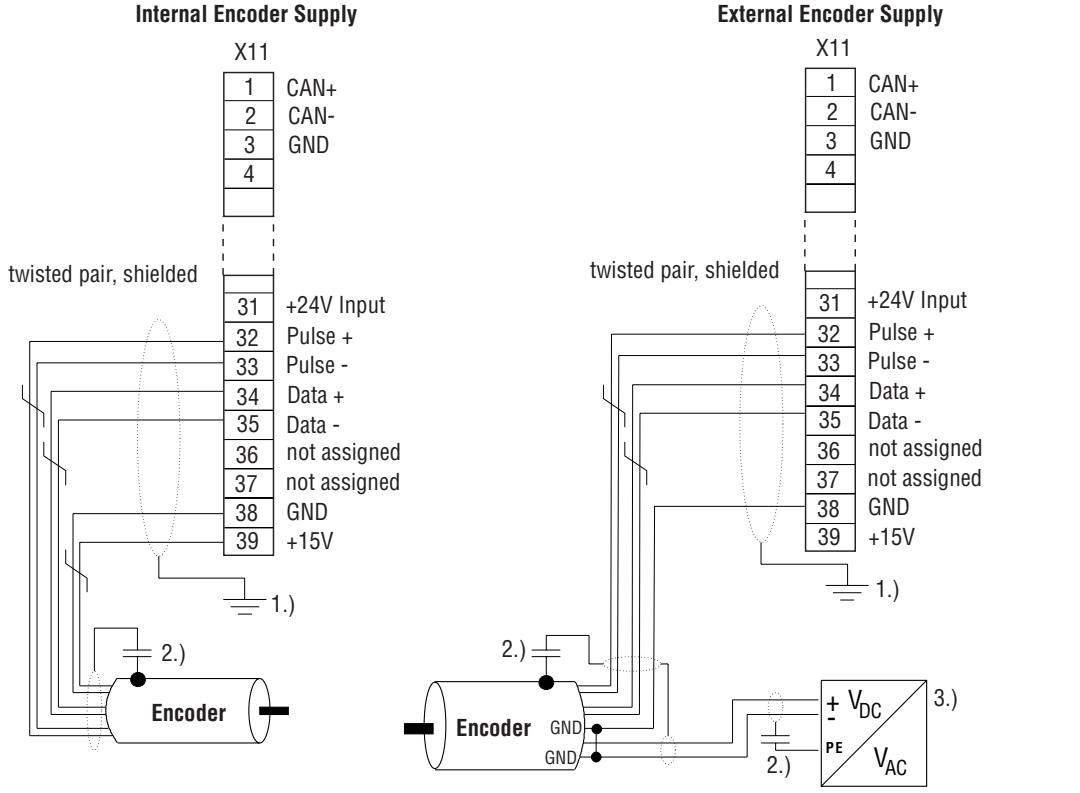


Fig. 4: Connection with internal and external encoder supply

1.) Earthing is to be provided once on the MOVIDYN® ; maximum lead length between encoder and MOVIDYN®: 100m
2.) Earthing as recommended by the manufacturer (recommended: capacitance earth, C = 22nF)
3.) Power supply (electrically isolated)

Notes on connecting the module (refer to Fig. 5)

- Please observe the notes and recommendations in the MOVIDYN® Servo Controller Operating Instructions , section 2.8.
- The input and output terminal connections shown in the terminal assignment diagram depict a standard implementation. All freely programmable terminals must be connected in accordance with your wiring diagrams.
- Max. lead cross section: 0.75 mm²
- Voltage output 24 V (terminals X11/13, X11/14):
  Voltage input 24 V to supply the binary outputs (terminals 30, 31):

If the load at terminals X11/13 and X11/14 from all activated binary inputs and binary outputs is < 180 mA, this voltage supply can be used to activate the respective inputs and outputs. In this case a jumper is placed between terminals 30 and 13 and between terminals 31 and 14 (wiring example see section 8.1).

For output currents > 180 mA an external voltage supply is required. In this case terminals 13 and 14 are not needed in order to supply the output terminals (see section 8.1).

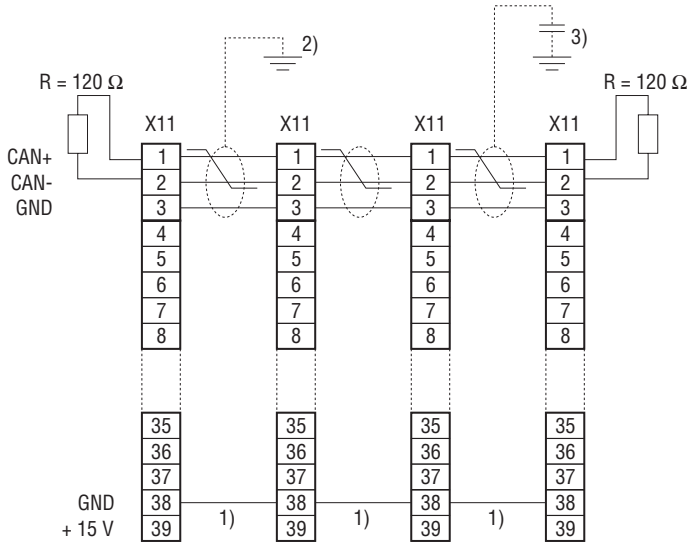
- Limit switch connection:
  Limit switches to limit the travel are connected to input terminals X21/7 and X21/8 of the axis module. These terminals must then be programmed to the functions “limit switch ccw” and “limit switch cw” respectively (see MD_SHELL). The limit switches must be zero-active (normally closed).

- Override connection:
  To execute a sequence programmed in a travel program with a speed greater or less than the one programmed, an analog setpoint can be applied to input terminals X21/2 and X21/3. This allows you to operate with a travelling speed between 0 and 150% (0V to 10V) of the programmed speed (e.g. for set-up purposes).

Note

Output X21/1 may be used as a voltage supply for an externally connected potentiometer used to operate the override.

- **Intalling the Can bus**



1) The jumber shown under 1) is only necessary if multiple independently powered axes (e.g. compact axes) are connected (maximum length 2 m). It is not necessary if axis modules are interconnected and supplied from a single power source.
2) The shield of the CAN cable may only be earthed directly once.
3) If further earthing measures are required, these must be implemented by means of a capacitor (C = 2 nF, RF earth)

Fig. 5: Installing the CAN bus 00007AEN

The CAN bus is connected to terminals X11/1 (CAN+), X11/2 (CAN-), and X11/3 (GND), directly from axis to axis (see Figure 5). The first and last station on the bus must be terminated with a 120 Ω resistor.

Recommended cable

– 4 x 0.5 mm^2 twisted pair, shielded
– 39 Ω / km line resistance
– 120 Ω surge resistance

Terminal assignment

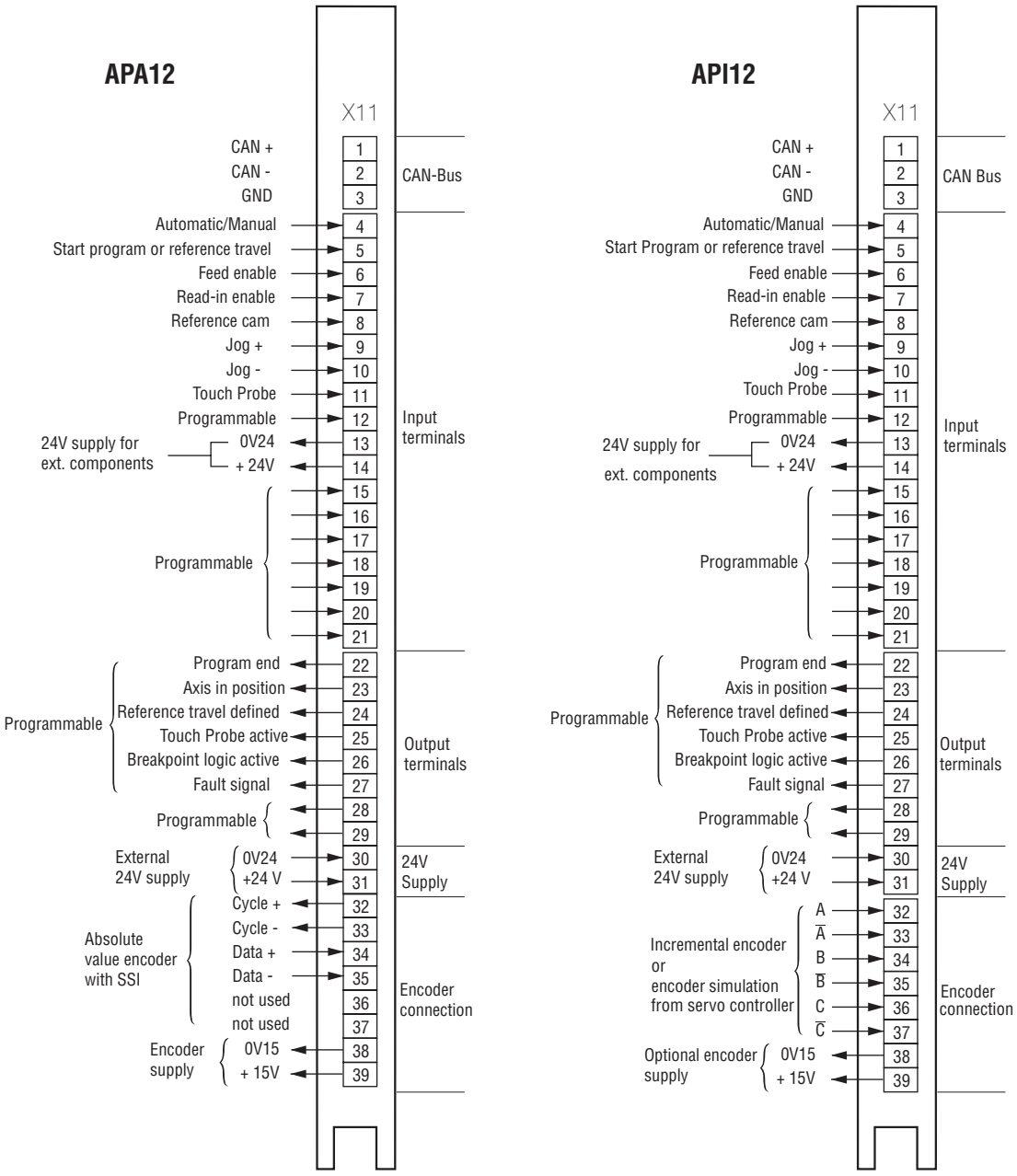


Fig.6: Terminal assignment of the APA 12 / API 12 single-axis positioning control option

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Function	Plug	Term.	Characteristics	
CAN bus	X11	1, 2, 3	Baud rate 500 KBit/s	
Binary inputs				as per DIN 19240
fixed		4	Automatic/Manual	
fixed		5	Progr./Ref. travel start	"1": +13V to
fixed		6	Feed enable	+30.2V
fixed		7	Read-in enable	
fixed		8	Reference cam	typical: 24V (6mA)
fixed		9	Jogging +	
fixed		10	Jogging -	"0": -3V to
fixed		11	Touch probe	+5V
fixed		12	-	
		15 ... 21	-	
Voltage output 24 V		13	0V24 = Reference potential 24 V	Ampacity:
for supply of binary inputs and outputs		14	+24V ± 1V	max. 180mA
Binary outputs				as per DIN 19240
freely programmable		22	Program end	
freely programmable		23	Axis in position	"1": + 2 4V
freely programmable		24	Reference position defined	max. 500 mA
freely programmable		25	Touch probe zero point logic active	per output
freely programmable		26	Breakpoint active	(ohmic load)
freely programmable		27	Fault signal	
freely programmable		28	-	
freely programmable		29	-	
Voltage input 24V[1)]		30	0V24 (A) = reference potential 24 V	
for supply of binary outputs		31	+ 24 V (A)	
Input encoder		32, 33	APA 12: pulse+, pulse- API 12: A, $\overline{A}$	RS-422 level
		34, 35	APA 12: data+, data- API 12:B, $\overline{B}$	
		36, 37	APA 12: not assigned; API 12: C, $\overline{C}$	
		38	0V15 = Reference potential	
Output voltage supply for ext. encoder			(Encoder simulation or external encoder)	Current rating: max. 240 mA
		39	+ 15V - 0.5/+2V	

Table: APA 12/API 12 terminal functions

[1)] Please read the notes on connecting the module in this section

Function	Plug	Term.	Characteristics	
Voltage output 10 V for override	X21	1	+10V (max. 3mA)	
Analog inputs		2	Voltage input override 0 ... 10 V	
		3	Reference potential override	
Binary inputs		5	Control inhibit	as per DIN 19240
		6	Freely programmable	"1": +13V to
		7	Limit switch CW	+ 30.2V
		8	Limit switch CCW	typical: 24V (6mA)
				"0": - 3V to
				+ 5V

Table: Terminal functions on the axis module

1.2 Software installation

The engineer commissioning the APA 12/API 12 single-axis positioning control must be familiar with

- the MOVIDYN® Servo Controller (mains and axis module),
- the operation of an MS-DOS PC and
- the MD_SHELL user interface used for configuring the positioning control.

Therefore basic operating steps are not discussed in the following instructions.

Connecting the PC

- Connect a PC, which meets the necessary hardware requirements, to the serial interface of the power supply module (see MD_SHELL, section 2.1).

Installing the software

- Insert the program diskette with the MD_POS program into the disk drive.
- Change to the drive where you have placed the installation diskette.
- Where MD_POS will be installed depends on where MD_SHELL is installed or will be installed. After the installation of MD_POS is complete, the MD_POS and MD_SHELL directories must be on the same hierarchical level. Below are two installation examples.

Example a)

MD_SHELL is located in the MD_SHELL directory on the C drive (hard disk)
Enter the following command:

```
INSTALL C:\MD_POS
```

After copying is complete you will find the following structure:

Generally, three languages are available: German, English and French.

```
C:\
├── MD_SHELL\
└── MD_POS\
    ├── DEUTSCH\
    ├── ENGLISH\
    ├── FRANZ\
    └── DATEN\
        ├── MD_POS .EXE
        ├── MD_POSA.EXE
        ├── POS_INFO.CFG
        ├── INSTALL.BAT
        ├── ACHSPRG.WRK
        ├── GEBERTYP.DAT
        └── KONFIG.DAT
```

Example b)

MD_SHELL is located in a subdirectory on the C drive (hard disk), e.g. C:\SEW\MD_SHELL
Enter the following DOS command:

INSTALL C:\SEW\MD_POS

After copying is completed you will find the following structure:

Generally, three languages are available: German, English and French

```
C:\
└── SEW\
    ├── MD_SHELL\
    └── MD_POS\
        ├── DEUTSCH\
        ├── ENGLISCH\
        ├── FRANZ\
        ├── DATEN\
        ├── MD_POS .EXE
        ├── MD_POSA.EXE
        ├── POS_INFO.CFG
        ├── INSTALL.BAT
        ├── ACHSPRG.WRK
        ├── GEBERTYP.DAT
        └── KONFIG.DAT
```

- Check the subdirectory structure by entering:
  C:\MD_POS dir or C:\SEW\MD_POS dir

If you have installed the files as shown in example b) you will have to enter the following changes:

- Edit the following files:

  a) **POS_INFO.CFG** is located in the MD_POS directory

  Change to the MD_POS directory
  EDIT POS_INFO.CFG (calls the editor)
  Add the path name from where MD_SHELL is called (2nd line).
  In the above example: C:\SEW\MD_SHELL

  b) **MD_SHELL** is located in the MD_SHELL directory
  Change to the MD_SHELL directory
  EDIT MD_SHELL.INI (calls the editor)
  Add the path name from where MD_SCOPE is to be called (8th line).
  In the above example: C:\SEW\MD_SCOPE
  Add the path name from where MD_POS is to be called (9th line).
  In the above example: C:\SEW\MD_POS

If the installation was carried out as shown in example a) no further modifications are needed.

The necessary software to operate the APA 12/API 12 single-axis positioning control is now installed on your PC.

You may start commissioning the APA 12/API 12 single axis positioning control (see section 2).

2 Commissioning

2.1 Safety Notices

- **Commissioning and service work on the unit may only be carried out by qualified and trained electrical personnel in conformance with the applicable accident prevention regulations and in strict compliance with all other applicable regulations and standards (e.g. EN 60204).**

- **Before removing the protective cover disconnect the unit from the mains. Dangerous voltages may prevail up to 10 minutes after power-down.**
- **With the protective cover, removed the unit has enclosure type IP 00.**
  Only the electronic terminals carry low voltages.
  The upper components of the unit carry dangerous voltages!
- **When the unit is energized, dangerous voltages are present at the output terminals, cables and motor terminals connected to them. This is also the case if the unit is disabled and the motor is at rest.**

- **Unlighted operating LEDs or other display elements are no indication that the unit is disconnected from the mains and de-energized.**
- **Internal safety features or mechanical blocking of the unit may cause the motor to stop. Eliminating the cause of the fault may cause the drive to restart automatically.**
  If automatic restart is not acceptable for the given application on the grounds of safety reasons, the unit must be disconnected from the mains prior to eliminating the fault. In this case activation of the "Auto reset" feature (P630) is strictly prohibited!

- **If there is no encoder connected to the actual value inputs of the APA 12/API 12, there is the danger that the axis will start up uncontrolled during commissioning, as the position controller does not receive an actual value signal!**

2.2 Activating the APA 12/API 12

2.2.1 Preparatory work

The MOVIDYN® Servo Controller and the APA 12/API 12 single-axis positioning control are programmed solely via a PC with the supplied MD_SHELL user interface and the MD_POS interface for the positioning control option respectively. Operation of the MD_SHELL interface is explained in the MD_SHELL manual (see MD_SHELL).

- Connect the switched-off power supply module to the PC with the interface cable if not already connected.
- Power up the MOVIDYN® Servo Controller.
- Start MD_SHELL.
- Select the PC serial interface to which the power supply module is connected.

- Start up the MOVIDYN® Servo Controller (see the MOVIDYN® Servo Controller Installation and Operating Instructions):

  – Set axes addresses.
    Make sure that interconnected axis modules are assigned different axes addresses as otherwise communication via the user interfaces is not possible (see the MOVIDYN® Servo Controller Operating Instructions section 3.2).
  – Deactivate the axis module (activate controller inhibit via the axis module at input X21/5 (=0)). Any settings relating to the operating mode, terminal assignment, setpoint source and factory setting are only accepted in the controller inhibit state.
  – Parameterize the speed controller to suit your requirements and transfer the data to the axis module (see the MOVIDYN® Servo Controller Installation and Operating Instructions section 3.3).

The commissioning of the MOVIDYN® Servo Controller including the correct setting of the speed controller must be complete before you can start commissioning the APA 12/API 12 single-axis positioning control.

2.2.2 Connecting the APA 12/API 12

To connect the APA 12/API 12 the controller inhibit must be activated (= 0).

- Calling MD_POS
  In MD_SHELL select the [Environment] option and then [MD_POS]. Close the information window by confirming [OK].
- Select the [Programming] option, then call the [Axis module] option.
- Enter the axis address.
- Select the [OPT.APA/API 12] line of the [Control mode] option.
- Select [Exit] to quit the menu.

Only call MD_POS from the MD_SHELL level, as MD_POS will obtain certain settings from MD_SHELL (e.g. selected language etc).

2.3 Setting machine parameters

- For the purposes of this section it is assumed that you are familiar with the MD_POS user interface (see section 6).
- The individual machine parameters are not discussed in this section (For a detailed description of the individual parameters: see section 3).

When commissioning the module for the first time all machine parameters must be set to suit your requirements. Load the machine parameters to your PC and change or define those parameters, which are important for your application and which deviate from the factory setting. Then transfer the programmed machine parameters to the axis and save them to a diskette or to the hard disk of your PC.

If you have already created a machine parameters file you can load this file from the hard disk or a diskette, edit it and then transfer it to the positioning module.

- Select the [Programming] menu.
- Select the [Machine par.] option.
  You will be prompted to specify where the data are to be loaded from:
  - Select [New] if you wish to redefine the machine parameters.
    The first page of the machine parameters menu will appear.
  - Select [Axis] if you wish to edit the machine parameters of an installed APA 12/API 12 unit.
    You will be prompted for the axis number.
    Enter the axis number and click [OK] to confirm.
    The first page of the machine parameters menu will appear.
  - Select [Disk] if you wish to edit the machine parameters of an axis saved to the hard disk.
    You will be prompted to specify the file to be opened. The file extension always is **.MPA.**
    Select the desired file from the file selection list and confirm your choice by clicking [Open].
    The first page of the machine parameters menu will appear.

2.3.1 Configuring terminals

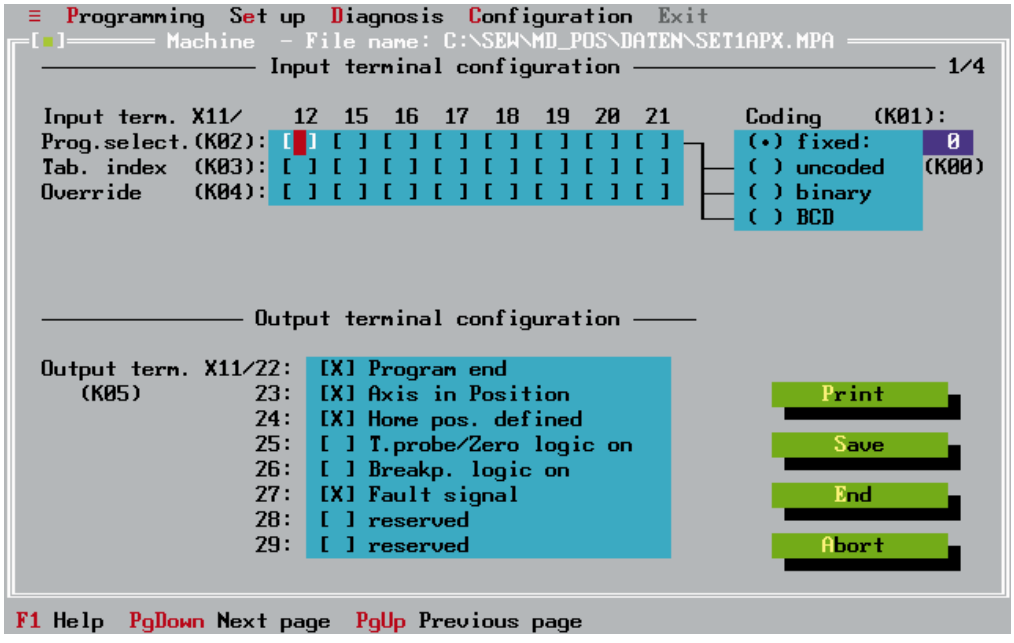
≡ Programming Set up Diagnosis Configuration Exit
Machine - File name: C:\SEW\MD_POS\DATEN\SET1APX.MPA
Input terminal configuration 1/4
Input term. X11/ 12 15 16 17 18 19 20 21
Prog.select. (K02): [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
Tab. index (K03): [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
Override (K04): [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
Coding (K01):
(•) fixed: 0
( ) uncoded (K00)
( ) binary
( ) BCD
Output terminal configuration
Output term. X11/22: [X] Program end
(K05) 23: [X] Axis in Position
24: [X] Home pos. defined
25: [ ] T.probe/Zero logic on
26: [ ] Breakp. logic on
27: [X] Fault signal
28: [ ] reserved
29: [ ] reserved
Print
Save
End
Abort
F1 Help PgDown Next page PgUp Previous page

Fig. 7: Machine parameter menu, page 1of 4, I/0 terminal configuration 0010AEN

On page 1 of the menu you can configure the input and output terminals:

- Configuration of the eight input terminals X11/12, 15 through 21 to function as:
  - program selection with coding (adjacent terminals)
  - table index selection (adjacent terminals)
  - override selection (see section 3.2.1)

- If program selection via the input terminals is not wanted, and instead the system will always be started with the same program, select [fixed] from the [Coding] field.
- Enter the corresponding program number in the adjacent entry field.
- Configuration of the eight output terminals X12/22,23,24,25,26,27,28,29

Enter the terminal configuration to suit your requirements. For a discussion of possible entries and a description of the terminal assignment: see sections 3.2.1 and 3.2.2. Select the second page of the machine parameter menu (PgDn key).

2.3.2 Scaling travel parameters

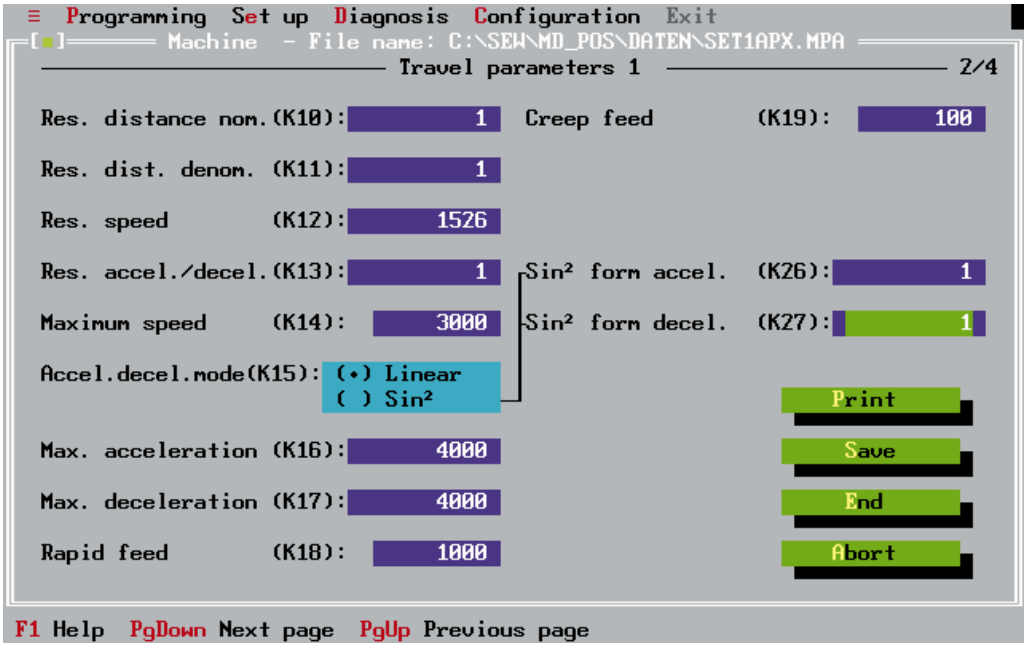

Fig. 8: Machine parameter menu, page 2 of 4, Travel parameters 1 00011AE

On page 2 you may enter the following travel parameters:

- K10 resolution distance numerator
- K11 resolution distance denominator
- K12 resolution speed
- K13 resolution accel./decel.
- K14 maximum speed
- K15 accel./decel. mode with form factors
- K16 maximum acceleration
- K17 maximum deceleration
- K18 rapid feed
- K19 creep feed
- K26 $\sin^2$-form acceleration
- K27 $\sin^2$-form deceleration

- Enter the travel parameters to suit your requirements.

  For a discussion of possible entries and a description of the individual parameters see section 3.2.3.

- Select the third page of the machine parameter menu (PgDn key).

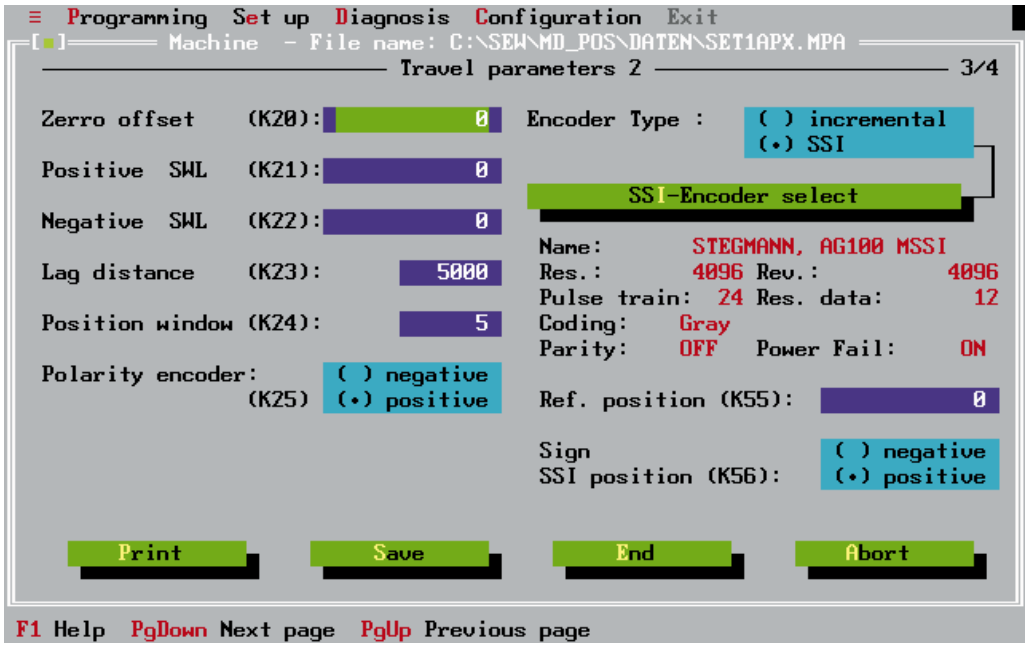

Fig. 9: Machine parameter menu, page 3 of 4, Travel parameters 2 00012AEN

On page 3 you may enter the following travel parameters:

- K20 zero offset
- K21 positive software limit switch
- K22 negative software limit switch
- K23 lag distance
- K24 position window
- K25 polarity encoder
- Encoder type
  depending on the encoder type:
  - SSI encoder selection
  - K55 reference position
  - K56 SSI position sign

If the appropriate encoder is not included in the selection list, it must be first added to this list before you may proceed further (→ Sec. 2.4).

- Enter the travel parameters to suit your requirements.

  For a discussion of possible entries and a description of the individual parameters see section 3.2.3.

- Select the fourth page of the machine parameter menu (PgDn key).

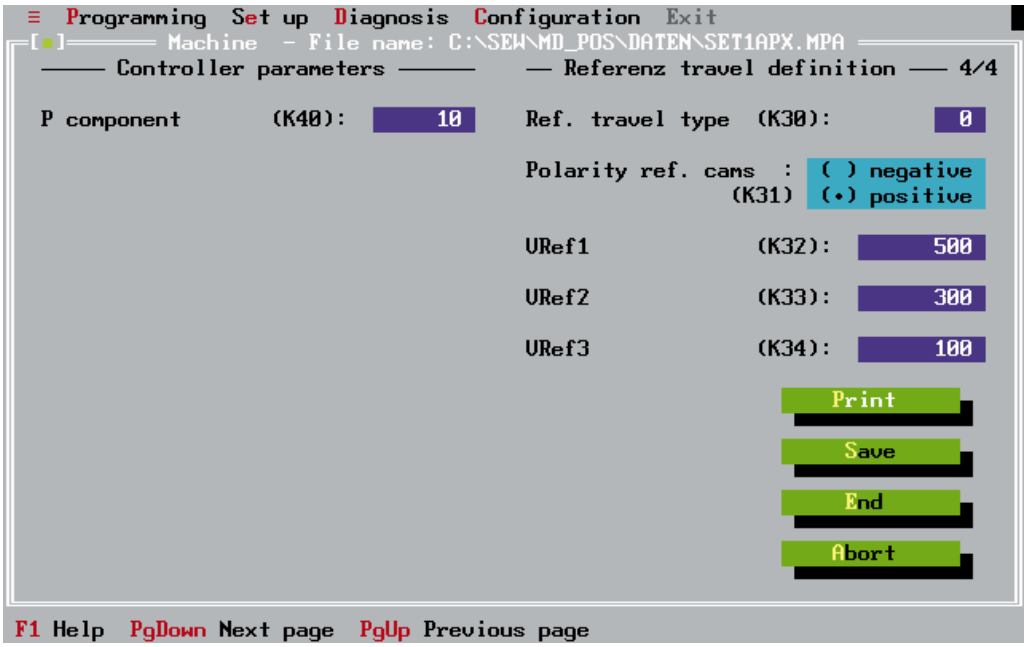

Fig. 10: Machine parameter menu, page 4 of 4, Controller parameters-Ret. travel def. 00013AEN

On page 4 you can enter the P component of the position controller and the reference travel definition.

2.3.3 Setting controller parameters

On the left you may enter the following controller parameters:

– K40 P component of the position controller

- Enter the P component of the position controller to suit your requirements.

  For a discussion of possible entries and their interaction with the speed controller setting see section 3.2.5.

2.3.4 Programming reference travel

On the right you may define the reference travel:

– reference travel type
– polarity reference cam
– speed VRef1
– speed VRef2
– speed VRef3

- Enter the parameters required for the reference travel definition to suit your requirements.

  For a discussion of possible entries and a description of the individual parameters see section 3.2.4.

2.3.5 Saving machine parameters

If you have followed the above instructions and have set all machine parameters in accordance with your design documentation, you will now need to transfer the machine parameters to the positioning control and save your data.

- Select [Save] if you want to remain in the [Machine parameters] menu. You will be asked where you want to save the data to. Select [Exit] to exit the [Machine parameters] menu after you have saved your data.
- Select where you want to save your data to:
  - Select [Axis] if you wish to send the machine parameters to the APA 12/API 12 positioning control.
    You will be prompted for the axis number.
  - Enter the axis number and click [OK] to confirm.
    The data will be transferred to the APA 12/API 12 and you will return to the main menu.

Important notes

- Exiting the machine parameters menu via the “Save to axis” option only means that the entered machine parameters have been transferred to the APA 12/API 12 for the axis to work with them. It does however not mean that the data have been stored in memory. To actually store the data they need to be saved to the non-volatile flash EPROM of the APA 12/API 12 and to the hard disk of the PC (see section 4.5).

- If you exit the machine parameters menu via the [Disk] option, the machine parameters are stored on the hard disk of the PC. In this case the newly entered machine parameters are not available to the axis. i.e. in order for the axis to work with the new parameters these still need to be transferred.

2.4 Setting encoder parameters

When you select the [Programming] / [Encoder] menu item, a selection of encoders is displayed on the screen. SEW has tested these encoders for correct interaction with the APA 12. This submenu allows you to enter other encoder's specifications. However, we are unable to guarantee the correct functioning of other encoders unless the required parameters have been set correctly and you have checked with us beforehand.

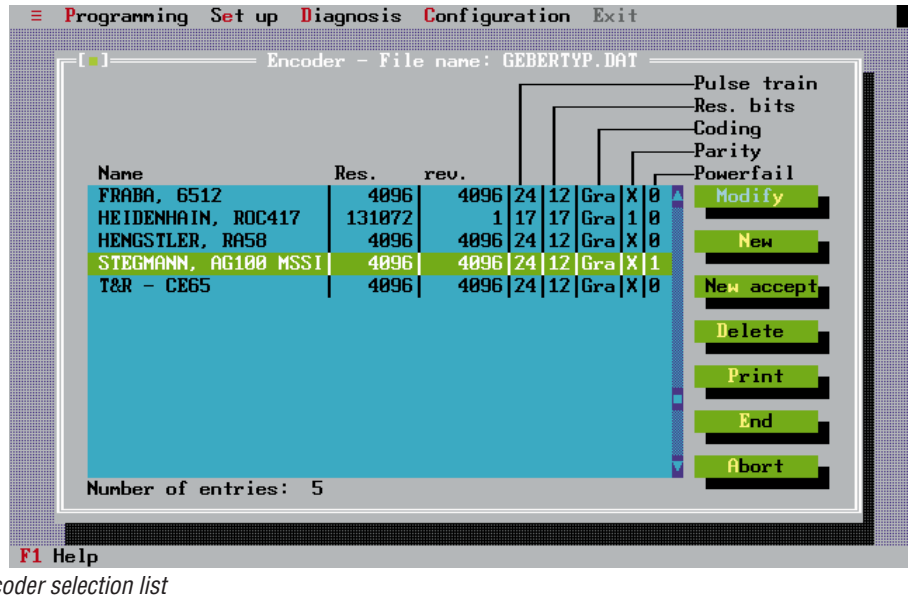

Fig. 11: Encoder selection list

00014AEN

If the specifications for an installed encoder are changed or a new one is installed, the following submenu is displayed.

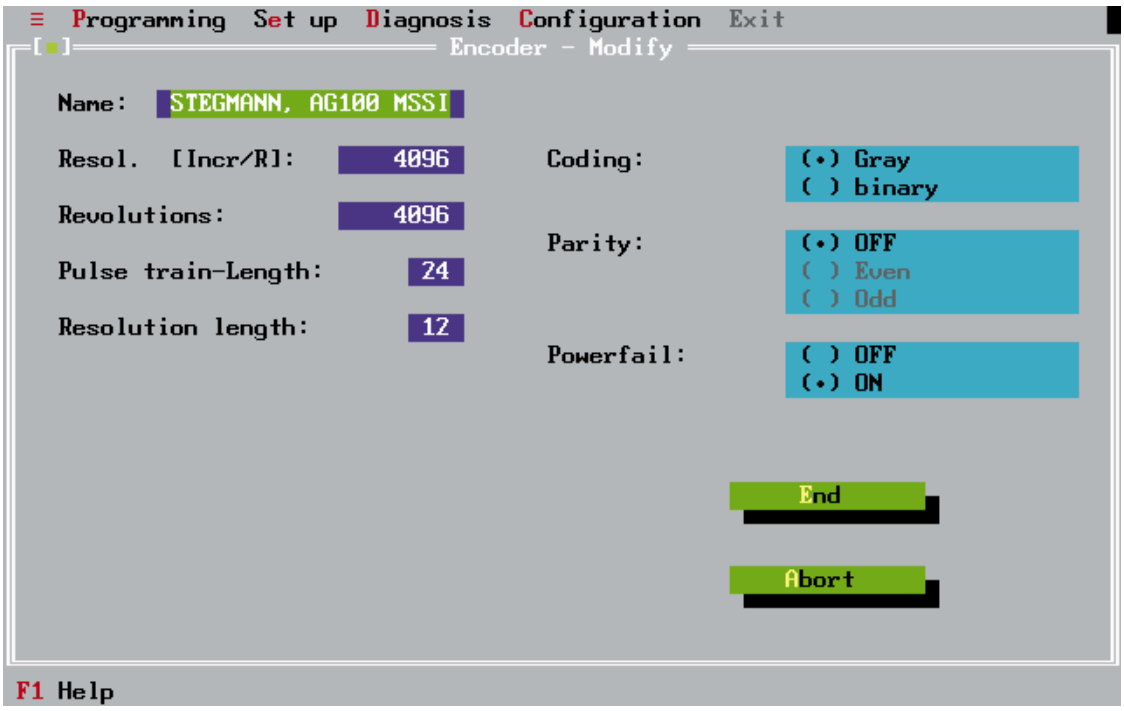

Fig. 12: Setting encoder parameters 00015AEN

Important:

Problems may arise when the APA 12 is operated with programmable absolute encoders. This is due to the following:

- The position update time of the APA 12 is 600 µs.
- Programmable encoders update the position value at an interval of > 1ms.

Since the APA 12 reads the same position several times within this 1 ms interval, greater changes may occur in the calculation of the setpoint speed than in the case of continuous position change. The higher the stiffness of the position and the speed control loop, the higher the current ripple and, consequently, the torque ripple. Increased motor noise during operation is an audible indication of such an increase in the current ripple.

With the SEW standard encoder AG 100 (Stegmann, t_{cycle} = 300 µs) this behaviour does not occur.

2.5 Axis module (speed controller)

Before you can commission and set APA 12/API 12 single-axis positioning control parameters, the commissioning of the axis module including the speed controller must be be properly completed (see the MOVIDYN® Servo Controller Operating Instructions).

If, while commissioning the APA 12/API 12 positioning control, it becomes apparent that the control response does not meet the requirements, it may be necessary to modify the parameters of the speed controller (axis module) to improve performance with the position control loop.

This can be done via the [Axis module] option of the [Programming] menu. It is not necessary to go to the MD_Shell interface in order to optimize the controller or clear a fault (fault reset).

- Select [Programming].
- Select [Axis module].
  You will be prompted for the axis number.
- Enter the number of the axis whose speed controller parameters you want to change and select [OK] to confirm. The submenu for setting the speed controller parameters (axis module) will open.

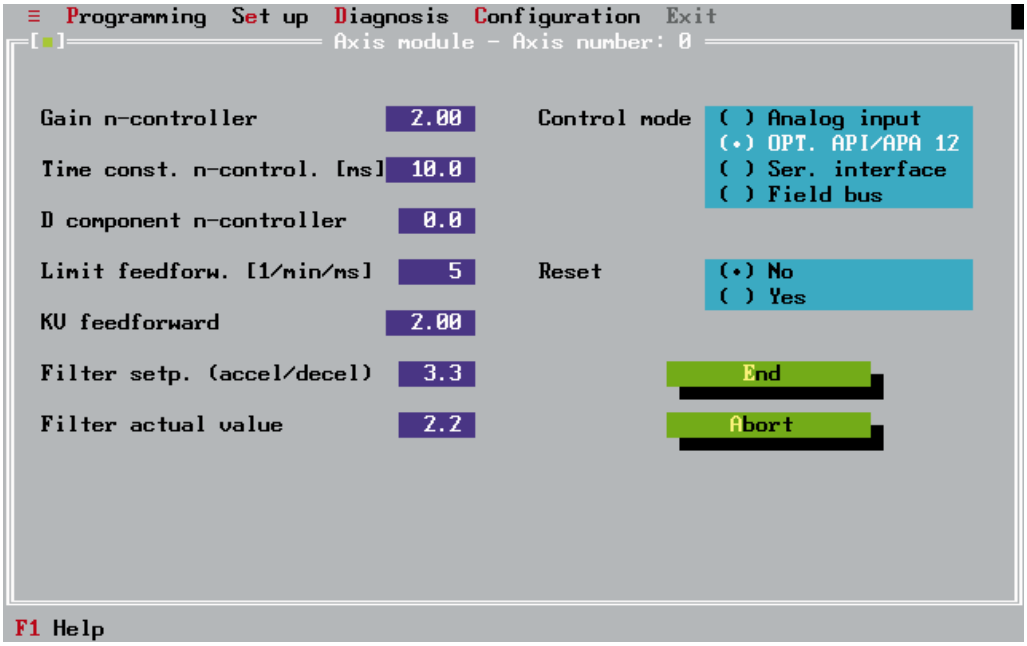

Fig. 13: Axis module (speed controller) submenu 00016AEN

You can set the following axis parameters:

Controller parameters

- Gain speed controller
- Time constant speed controller (ms)
- D component speed controller
- Limit feedforward
- KV feedforward
- Filter setpoint (accel.)
- Filter actual value
- Control mode (= setpoint source)
- Reset (fault no. < 50)

- Change the controller parameters as required or make other modifications.

  For a discussion of possible entries and individual parameters please refer to the MOVIDYN® Servo Controller Operating Instructions .

- Select [End] when you have completed your entries.
  The data will be saved and at the same time stored in the axis module. This will take you back to the main menu. By quitting the menu without selecting the [End] option, the edited data will not be transferred to the axis module.

2.6 Performing a function test

After entering the machine parameters a short function test (travelling in manual mode) is required to ensure that the APA 12/API 12 positioning control has been configured correctly. Make sure before performing the function test that the positioning control is not in automatic mode (Term XII.4 is low).

- Select [Set-up].
- Select [Manual mode].
  You will be prompted for the axis number.
- Enter the number of the axis for which you want to carry out a functional test and click [OK] to confirm. The manual mode submenu will open.

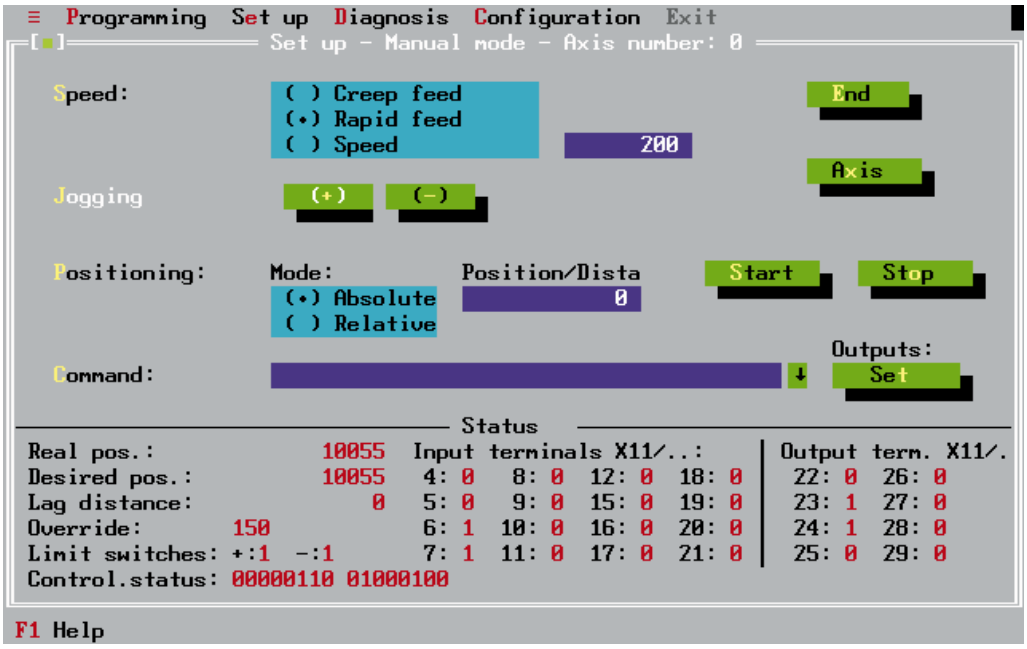

Fig. 14: Manual mode screen 00017AEN

- Select [Creep feed] or [Rapid feed] or enter a [Speed].
- Click on the Jogging+ field. The axis should travel in the positive direction.
- Click on the Jogging- field. The axis should travel in the negative direction.
- Perform a reference travel if your application requires a reference travel (see section 4.2.2).

Note

To check the resolution of the distance travelled (see section 2.3, “Setting machine parameters”) travel a certain distance [absolute] or [relative] by selecting the [Positioning], [Mode] and [Position/Distance] fields. Select the desired mode, enter the distance and start the positioning. The positioning will be performed at the travelling speed specified in the [Speed] parameter and in accordance with the specified resolution.

- If the test was successful, the first commissioning of the APA 12/API 12 single-axis positioning control is completed. How to program a travel program for your particular application is discussed in section 7.1.
- If the test did not prove successful, check the individual machine parameters again and correct them if necessary (see section 3).
- Select [Exit] to exit the [Manual mode].

3 Machine Parameters

3.1 Overview/Value ranges

The machine parameters serve to customize the APA 12/API 12 to the particular application. Parameters such as terminal assignment, acceleration and deceleration ramps, maximum speed, reference travel settings, and conversion factors for distance, speed, and acceleration units are adjustable under the Machine Parameters submenu of the APA 12 /API 12.

General information about machine parameter entry

The following table contains a listing of all parameters, which can be defined when commissioning and configuring the APA 12/API 12 single-axis positioning control. There are two ways of entering the parameters:

– You can select or enter the parameters in the [Machine parameters] menu
or
– Enter them in the command line of the [Manual mode] menu option.

In the [Machine parameters] option, the parameters are entered by direct selection of a field [X] (i.e. terminal setup) or by entering a value in a field. After saving the “Machine parameters” file the data are transferred to the APA 12/API 12 and are then used in conjunction with the travel program. Use of the [Machine parameters] option is preferrable to the use of the [Manual mode] option since it doesn't require entry of the parameter designations (see notice below).

Safety notice

If you enter parameters in the command line of the [Manual mode] menu you must use their name code designation (e.g. %K12..., see section 7.2). For safety reasons this type of entry should be left to experienced programmers, who are already familiar with the APA 12/API 12. With this type of entry the MD_POS user interface processes the entered command and, on pressing the “Return” key, will send it to the APA 12/API 12 via its serial interface. The parameter becomes effective immediately. The entered data, must also be stored to EEPROM separately as it is only present in the APA 12/API 12’s main memory.

In the [Manual mode] parameters K02 through K05 are transferred in “hexadecimal bitmapped” format. Please remember that the binary values are converted to hexadecimal values!

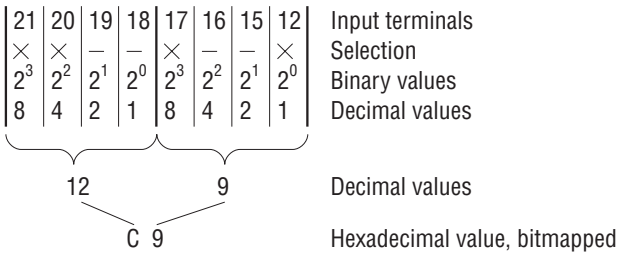

Fig. 15: Converting the binary values of the input terminals to the “ hexadecimal bitmapped” format of parameters K02 to K05

Para-meters	Designation	Entry in MD_POS [1]	Value range (Command)	Setting	
				Factory set.	after commiss.
K00	Source program number	00 ... 99	00 ... 99	0	
K01	Coding program number	X in corresp. field (i.term)	0 ... 3	0	
K02	Config. program number (Program selection)	X in corresp. field (i.term)	hexadecimal bitmapped 00 ... FF	00	
K03	Configuration table index	X in corresp field (i.term)	hexadecimal bitmapped 00 ... FF	00	
K04	Configuration override enable	X in corresp. field (i.term)	hexadecimal bitmapped 00 ... FF	00	
K05 **Output terminals**	X11/22 X11/23 X11/24 X11/25 X11/26 X11/27 X11/28 X11/29	X in field 22 X in field 23 X in field 24 X in field 25 X in field 26 X in field 27 X in field 28 X in field 29	hexadecimal bitmapped 00 ... FF [2]	0 0 0 0 0 0 0 0	
K10	Resolution distance numerator	Incr./rev	1 ... 2^{31}	1	
K11	Resolution distance denominator	Dist.unit/rev.	1 ... 2^{16}	1	
K12	Resolution speed	Factor	1 ... 2^{30}	1526	
K13	Resolution accel./decel.	Factor	1 ... 2^{30}	1	
K14	Maximum speed	Speed unit	1 ... 9999999	3000	
K15	Accel./decel. mode	0 / 1	0 / 1	0	
K16	Max. acceleration	Accel. unit	1 ... 2^{30}	2000	
K17	Max. deceleration	Decel. unit	1 ... 2^{30}	2000	
K18	Rapid feed	Speed unit	1 ... 9999999	1000	
K19	Creep feed	Speed unit	1 ... 9999999	200	
K20	Zero offset	Dist. unit	1 ... $\pm 2^{30}$	0	
K21	Pos. software limit switch	Dist. unit	1 ... $\pm 2^{30}$	1 000 000	
K22	Neg. software limit switch	Dist. unit	1 ... $\pm 2^{30}$	- 1 000 000	
K23	Lag error tolerance	Incr.	0 ... 32767	5 000	
K24	Position window	Incr.	1 ... 32767	5	
K25	Polarity encoder	0 / 1	0 / 1	1	
K26	Sin^2 form factor acceleration	Accel. unit	1 ... 2^{30}	10	
K27	Sin^2 form factor deceleration	Decel. unit	1 ... 2^{30}	10	
K30	Reference travel type	0 ... 8	0 ... 8	0	
K31	Polarity ref. cam	0 / 1	0 / 1	0 (positive)	
K32	Vref1	Speed unit	1 ... 9999999	100	
K33	Vref2	Speed unit	1 ... 9999999	50	
K34	Vref3	Speed unit	1 ... 9999999	10	
K40	P component (position controller)	0 ... 32767	0 ... 32767	5	
K55	Reference position	Incr.	1 ...$\pm 2^{30}$	0	
K56	SSI position sign	0 / 1	0 / 1	1 (positive)	

Table: Parameters K00 to K56

1) Abbreviations: i.term = input terminals, accel./decel.unit = acceleration/deceleration unit, dist. unit = travel distance unit, incr. = increments, rev. = revolutions

2) Logic 0 = output freely assignable, logic 1 = output with fixed functional assignment

3.2 Parameter description

3.2.1 Input terminals

The status of all 16 input terminals can be read and used in a travel program, for example with conditional jump instructions or program calls.

Some of the terminals are permanently assigned a certain function, others are freely assignable.

Safety notice

The "Enable" and "Hold control" functions of the MOVIDYN® Servo Controller are not effective when using the APA 12/API 12. The enable must be given via terminals X11/6 and X11/7 of the APA 12/API 12. Deceleration and acceleration operations are carried out solely with the values set in the machine parameters.

Input terminals with fixed assignment

Input terminals X11/4 to X11/11 are permanently assigned to a certain function and, unlike the freely assignable input terminals, cannot be redefined.

Terminal	Function	Meaning
Input terminal X11/4	Automatic	Select the "Automatic" operating mode (see section 4.2.6, "Automatic mode")
Input terminal X11/5	Start 1)	Start program in automatic mode or start reference in manual mode
Input terminal X11/6	Feed enable	The feed enable is required for all axis movements. It enables feed motion of the axis. If the signal is removed (low level) during an axis movement, the axis is stopped immediately at the deceleration rate specified in the machine parameters. The position control will remain active. The deceleration ramp is always linear and corresponds to the steepest ramp specified in K16 or in K17. If the signal is reapplied, the interrupted movement is continued with the currently valid acceleration.
Input terminal X11/7	Read-in enable	The read-in enable is only effective in the automatic mode and allows the lines of a program to be processed. If the signal is removed (low level), the program is interrupted while an ongoing positioning operation will still be completed. If the signal is reapplied, the program will be continued at the point where it was interrupted before.
Input terminal X11/8	Reference cam	The reference cam signals that the axis has identified the home position when carrying out the reference travel. (see section 4.2.2, "Performing a reference travel").

Table: Input terminals X11/4 to X11/11, part 1

1) This function is actuated by the positive edge of the signal.

Terminal	Function	Meaning
Input terminal X11/9	Jog + 1)	The jogging+ signal (high level at X11/9) causes the axis to travel in the positive direction (see section 4.2.3, "Travelling in jogging mode").
Input terminal X11/10	Jog - 1)	The jogging- signal (high level at X11/10) causes the axis to travel in the negative direction (see section 4.2.3, "Travelling in jogging mode").
Input terminal X11/11	Touch probe	The "Touch probe" logic is activated by a program command. If a low-high edge is identified at this input, the actual position of the axis is sensed and a certain action takes place depending on the touch probe definition initiated (e.g. reading the actual position to variable).

Table: Input terminals X11/4 to X11/11, part 2

1) This function is actuated by the positive edge of the signal.

Freely assignable input terminals

The functions of input terminals X11/12, X11/15 through X11/21 are individually assignable, they can be custom-assigned to suit the requirements of the particular application.

In addition to their free use in the travel program, these input terminals can be assigned the following three functions:

– Selection of the desired travel program (program number)
– Selection of a table position (axis travel to a certain position)
– Activation/deactivation of the override

The terminals are configured in the [Machine parameters] menu when the positioning module is configured (see section 2.3, "Setting the machine parameters"). You may, however, also configure the input terminals directly by entering the respective commands in the command line in the [Manual mode] menu.

Note

If you do not use a mouse to operate the program, you can select the terminals by pressing the space bar. Press the TAB key to get to the desired field.

- **Program number: Input terminals X11/12, X11/15 through X11/21**
  adjacent terminals

  If configured, these inputs are used to select the program to be executed in the automatic mode either uncoded, binary or BCD coded (also see machine parameters K01 and K02).

  Programming options:

  Only one program in use
  The program is not determined by the input terminals, but by selecting a single program number:

  In the [Machine parameters] menu:
  select field Fixed [X] and enter the program number in the [Coding] field.

In the [Command line] of the [Manual mode] menu:

enter **%K01:0**

and **%K00:nn** (nn= program number).

Uncoded

Each of the terminals selected in the machine parameters menu has a program number permanently assigned. There is a choice of max. 8 programs.

In the [Machine parameters] menu:

Select the desired terminals [X].

In addition select [uncoded] [X].

Example:

Terminal X11/	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**12**	
Permanently assigned prog. no.	07	06	05	04	03	02	**01**	00	
Prog. selection					[X]	[X]	[X]	[X]	
Level					L	L	**H**	L	⇒ Progr. no. 01

The travel program corresponding to the high input terminal will be active (00 to 03). Only one of the configured terminals may be high at a given time (all other configured terminals must be low).

If more than one input terminal is high, the program corresponding to the active input terminal with the smallest value is selected.

Example:

Input terminals 12, 15 and 16 are high → program no. 00 is selected.

In the [Command line] of the [Manual mode] menu:

Parameter K01 **%K01:1**

The input terminals used for program selection are determined in parameter K02 (hexadecimal/bit-mapped 00 ... FF)

Example:

%K02:0F The program number is selected via terminals 12, 15, 16 and 17(Binary: 0000 IIII).

Binary coded

A maximum of four adjacent terminals can be assigned. The level of the terminals is read in binary code, thus offering a choice of up to 16 programs.

In the [Machine parameters] menu:

Select a maximum of four adjacent terminals [X].
In addition select [binary] [X].

Example:

Terminal X11/	21	20	19	18	17	16	15	12	
Value					2^3	2^2	2^1	2^0	
Prog. selection					[X]	[X]	[X]	[X]	
Level					L	L	L	H	⇒ Progr. no. 01
Level					H	L	H	L	⇒ Progr. no. 10
Level					H	H	H	H	⇒ Progr. no. 15

Depending on which of the input terminals (12, 15, 16 or 17) is high, the travel program corresponding to the binary value of the terminals is called (00 to 15). Terminal 12 is the LSB (least significant bit) of the binary selection.

In the [Command line] of the [Manual mode] menu:

Parameter K01 **%K01:2**

The input terminals used for program selection of the program numbers are determined in parameter K02 (hexadecimal/bitmapped 00 ... FF)

Example:

%K02:0F The program number is selected via terminals 12, 15, 16 and 17 (Binary: 0000 IIII).

BCD coded

A maximum of eight terminals can be assigned. The level of the terminals is read in BCD code, offering a choice of up to 100 programs (00 ... 99). The first four terminals (12, 15, 16, 17) set the digit in the unit's place, the second group of four (terminals 18, 19, 20, 21) the ten's place. Unit digit and tens are read separately and can be defined between 0 and 9 (= binary-coded-decimal = BCD).

If only four terminals are assigned, a maximum of 10 programs can be selected (0 ... 9).

In the [Machine parameters] menu:

Select all eight terminals [X].
In addition select [BCD] [X].

Example:

Terminal X11/	21	20	19	18	17	16	15	12	
Value	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	
Prog. selection	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	
Level	L	L	L	H	L	L	L	H	⇒ Progr. no. 11
Level	L	L	H	L	H	L	L	L	⇒ Progr. no. 28
Level	L	H	L	H	H	L	L	H	⇒ Progr. no. 59

The travel program corresponding to the BCD value of the terminals with high level is called (00 to 99).

In the [Command line] of the [Manual mode] menu:

Parameter K01 **%K01:3**

The input terminals used for program selection are determined in parameter K02 (hexadecimal/bitmapped 00 ... FF)

Example:

%K02:FF The program number is selected via all terminals 12, 15 through 21.

- **Table position index: Input terminals X11/12, X11/15 to X11/21**
  adjacent terminals, maximum four

  If configured, these inputs can be used to execute travel commands to positions which are selected based on the present table index. The four adjacent terminals are read out in binary code.

  The table position corresponding to the binary value of the input terminals is used in the travel command (00 to 15).

  In the [Machine parameters] menu

  select four adjacent terminals [X]

  Example:

Terminal X11/	21	20	19	18	17	16	15	12	
Value					2^3	2^2	2^1	2^0	
Tab. index					[X]	[X]	[X]	[X]	
Level					L	L	L	H	⇒ Progr. no. 01
Level					H	L	H	L	⇒ Progr. no. 10
Level					H	H	H	H	⇒ Progr. no. 15

  In the [Command line] of the [Manual mode] menu:

  Parameter K03 determines which input terminals are used for the selection of table positions (hexadecimal/bitmapped 00 ... FF).

  If GOT commands are used, this parameter determines at which input terminals the table position index appears in (see section 7.3.2.4).

  Example:

  %K03:E0 The table index is selected via terminals 19, 20 and 21(Binary III0 0000).

Note

If no adjacent terminals are assigned when the program number and the table index selection are programmed, the input representing the “gap” is always skipped when the program number or the table index is decoded.

Example:

To select the table index, inputs 12, 15, 17 are assigned. Terminal 16 is left unassigned (“gap”). The selection of table index 4, 5, 6, 7, 12, 13, 14, 15 is no longer possible.

- **Override enable: any input terminal X11/12, X11/15 through X11/21**
  If configured, one of these inputs can be used to activate or deactivate the override function.

  In the [Machine parameters] menu:

  Select one of the terminals [X].

  Example:

Terminal X11/	21	20	19	18	17	16	15	12	
Value	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
Override								[X]	
Level								H	⇒ Override avctivated

  In the [Command line] of the [Manual mode] menu:

  To select the input terminal for activating/deactivating the override, use parameter K04 (hexadecimal).

  Example:

  %K04:80 The override is activated/deactivated via terminal 21 (Binary: I000 0000).

3.2.2 Output terminals

Configurable output terminals

The functions of output terminals X11/22 to X11/29 are configurable. The terminals are set up in the machine parameters. If left unassigned, the outputs, can be controlled in the user program (also see machine parameter K05).

Note

If you do not use a mouse to operate the program, you can select the terminals with the space bar. Use the TAB key get to the field of your choice.

The configurable output terminals are coded hexadecimally.

In the [Machine parameter] menu:

– Outputs with permanently assigned functions are selected [X].
– Terminals to be controlled in the user program are left unselected.

Example:

Terminal	Selection	Value	Assigned function
X11/22	[X]	2^0	Program end
X11/23	[X]	2^1	Axis in position
X11/24	[X]	2^2	Home position defined
X11/25	[X]	2^3	T.probe/zero logic on
X11/26	[X]	2^4	Breakp. logic on
X11/27	[X]	2^5	Fault signal
X11/28	[X]	2^6	reserved
X11/29	[X]	2^7	reserved

Note

Terminals X11/28 and X11/29 can be marked as “reserved”. This allows you to switch off outputs, which are set in a program, for test purposes. This will avoid you having to change the travel program. Terminals marked “reserved” can no longer be influenced by programs or the manual mode.

If you do not require one of the factory-set permanent assignments and prefer the terminal to be freely assignable, leave the assignment [X] empty (i.e. no entry in the field).

For a description of the fixed functions, see the table following this section.

In the [Command line] of the [Manual mode] menu:

The configuration of the output terminals is transferred to the control via parameter K05 (in manual mode). The eight terminals are read in hexadecimal code where:

– 1 = fixed function
– 0 = free

Example:

%K05:0E

The output terminals X11/22, 26, 27, 28 and 29 are freely assignable. The output terminals X11/23, 24 and 25 have a function assigned. (Binary: 0000 1110)

Terminal	Function	Meaning
Output terminal X11/22	Program end	If configured this output, in the automatic mode, signals the end of program execution: High level no program executed Low level program execution in progress
Output terminal X11/23	Axis in position	If configured this output indicates whether the axis is inside the positioning window: High level axis inside positioning window Low level axis outside positioning window
Output terminal X11/24	Home position defined	If configured this output signals whether the home position is defined, which is either by reference travel or the acceptance of the actual position as home position: High level reference travel successfully completed Low level reference travel not yet complete
Output terminal X11/25	Touch probe or zero pulse logic active	If configured this output is set to logic "1" as soon as the corresponding "Touch probe" command or, with the reference travel, the zero logic becomes effective. The output is reset on receiving the touch probe signal or the zero pulse. High level The touch probe logic is activated via a corresponding command. The touch probe signal has not been received yet at terminal X11/11 or the zero pulse logic in the last phase of the reference travel is activated, the zero pulse however has not been received yet. Low level After receipt of the touch probe signal or the zero pulse
Output terminal X11/26	Breakpoint logic active	If configured this output is set to logic "1" as soon as the command to set a breakpoint (absolute or relative) becomes effective. It is reset after the breakpoint is reached. High level the breakpoint logic is activated with the SET BA or SET BR commands, the breakpoint position however has not been reached yet (see section 7.3.2.3) Low level when breakpoint has been reached
Output terminal X11/27	Fault signal	If configured this output is set to logic "1" as soon as the axis module has tripped a fault signal. Reset: Fault number <50: reset at axis module Fault number ≥50: clear fault window in MD_POS enter %RES in [Manual mode] High level axis module has caused fault signal Low level no fault signal
Output terminal X11/28	reserved	Reserved, serves as wildcard for future APA 12/API 12 features. If the output is not selected the outputs are freely assignable in the program.
Output terminal X11/29	reserved	Reserved, serves as wildcard for future APA 12/API 12 features. If the output is not selected, the outputs are freely assignable in the program.

Table: Output terminals X11/22 to X11/29

3.2.3 Travel specific parameters

3.2.3.1 Determining the units for the travel specific parameters

Obviously the user will want to enter values for distance, speed and acceleration in the travel commands or the command line of the manual mode menu in MD_POS in common units such as mm, m/s, m/s^2 etc. The positioning control internally, however, uses the unit "increments" to represent the distance travelled, the unit "increments/sampling time" for the speed and the unit "increments/sampling time^2" for the acceleration/deceleration. The sampling time is the internal sampling time to calculate the speed setpoint of t = 341 µs.

To enable the user to enter the values in common units, machine parameters K10 through K13 are used, where these conversion factors are entered. The following values are set as standard values after the first commissioning of the APA 12/API 12:

	API 12 internal	**Preset in MD_POS**	
Variable	**Unit**	**Unit**	**Parameter value (conversion factor)**
Distance travelled	Increments	Increments	Resolution distance numerator (K10) = 1 Resolution distance denominator (K11) = 1
Speed	$4.47 \cdot 10^{-2}$ incr./s	rev./s	Resolution speed (K12) = 91560
Accel./Decel.	$1.31 \cdot 10^{+2}$	rev./s	Resolution accel./decel. (K13) = 31

Compared to the encoder resolution, the API has a resolution of 4 x encoder resolution.

$$Z_{API} = Z_{encoder} \cdot 4$$

Example:

$Z_{encoder}$ = 1024 increments/revolution

$\Rightarrow$ Z_{API} = $1024 \cdot 4 = 4096$ increments/revolution

When absolute encoders are used, the position is transferred directly, without the 4 x increase in resolution.

Section 8.2 contains an example of a complete calculation of the travel specific parameters as well as all other machine parameters based on a hypothetical system configuration.

The following explanations refer to the drive configuration shown below and apply to other setups analogously:

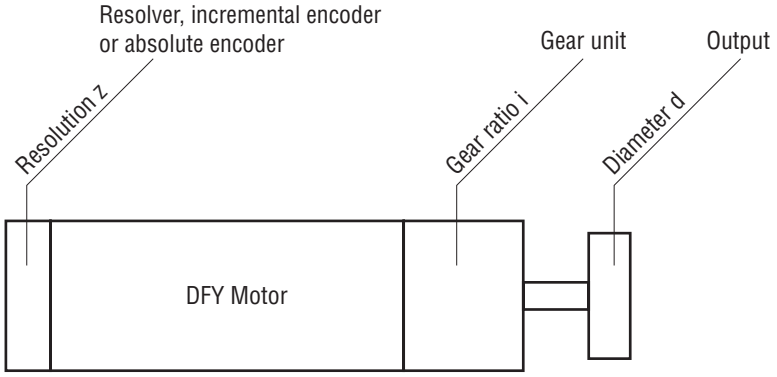

Fig. 16: Example of a drive configuration

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Calculating the unit of the "distance" parameter

The positioning control always calculates in "increments" internally to represent an absolute or relative distance travelled. The general calculation formula is:

$$X_{API}[\text{increments}] = \frac{\text{Distance resolution numerator (K10)}}{\text{Distance resolution denominator (K11)}} \cdot X_{command}$$

$X_{command}$ = distance specified in a travel command

Parameter K10 represents the number of increments per output revolution received in the APA 12/API 12.

K10 is calculated:

$$K10 = Z_{encoder} \cdot 4 \cdot i$$

i = gear ratio

Parameter K11 represents the distance travelled per revolution of the drive. If the distance is entered as distance travelled e.g. if the diameter of a drive wheel is given, this factor is:

$$K11 = d_{output} \cdot \pi$$

The fraction K10/K11 is the number of increments relative to the desired distance unit. The formulas to calculate common distance units are given below:

a) Distance in [mm] of the drive

Distance resolution numerator (K10)	$= Z_{API} \cdot i$
Distance resolution denominator (K11)	$= d \cdot \pi$

b) Distance in [increments]

Distance resolution numerator (K10)	= 1
Distance resolution denominator (K11)	= 1

The maximum travel range is limited to $X_{max} = \pm 2^{30}$ increments. To ensure the maximum possible travel range, K10 and K11 should be reduced to the smallest possible values.

Example:

Instead of distance resolution numerator:	4096 and
distance resolution denominator:	120
distance resolution numerator:	512 and
distance resolution denominator:	015 should be used.

Important

Make sure that the product of K10 and the distance specified in the command is not greater than $\pm 2^{30}$, as otherwise a fault message (F74) will be issued and the automatic program will be stopped.

Note

If the gear ratio "i" is specified in fractions of the individual gear ratios in the gear unit, the numerators of these fractions are to be included in K10 and the denominators in K11.

With parameters K10 and K11 defined, all machine parameters relating to distance are to be specified in the selected units (e.g. software limit switches etc).

Important!
The maximum motor speed is 3000 1/min.

Calculating the unit of the "speed" parameter (K12)

The positioning control internally calculates in "increments/sampling time" to represent the speed. The sampling time is t_{sample} = 341 µs.

This time is the time basis for the speed calculation. The speed value 1 increment/sample corresponds to an internal representation of 2^{16} (65536).

The general calculation formula is:

$$V[\text{increment/sample}] = K12 \quad \frac{V_{command}}{Z_{APA/API} \cdot 65536 \cdot 341\ \mu s} = \frac{V_{command}}{Z_{APA/API} \cdot 22.35 s}$$

Factor K12 can now be calculated by transposing the equation.

Below are some examples of speed values specified in common units:

a) Speed in [revolutions/s]

$$K12 = Z_{APA/API} \cdot 22.35\ s$$

b) Speed in [revolutions/min]

$$K12 = \frac{Z_{APA/API} \cdot 22.35\ s}{60s}$$

c) Speed in [mm/s]

If the linear distance travelled at the output is included in the speed specified, the general formula is:

$$V[\text{increment/sample}] = K12 \cdot \frac{\Delta s}{i} \cdot \frac{V_{command}}{Z_{APA/API} \cdot 22.35\ s}$$

Δs = distance in the selected unit

K12 is calculated as:

$$K12 = \frac{Z_{APA/API} \cdot i}{VK} \cdot 22.35\ s$$

VK= feed forward constant per revolution ($d_{drive} \cdot \pi$)

d) Speed in [m/s]

$$K12 = \frac{Z_{APA/API} \cdot i}{VK} \cdot 22.35\ s \cdot 1000$$

Caution

Make sure that the product of K12 and the command value does not exceed a range of 2^{30}, as this would result in an undefined speed. There is no monitoring of the limits.

With machine parameter K12 defined all parameters relating to speed are to be specified in the selected unit.

Calculating the unit of the "Accel./Decel." parameter (K13)

Maximum acceleration and deceleration are specified in machine parameters K16 and K17. If this entry is to be in certain units, parameter K13 is to be set accordingly.

Acceleration and deceleration in the APA 12/API 12 are calculated in increments/sampling time^2.

where:

$$a_{accel.}[\text{increments/sampling time}^2] = K13 \cdot \frac{K15}{65536 \cdot Z_{APA/API} \cdot (341\ \mu s)^2} = \frac{K16 \cdot 131\ s^{-2}}{Z_{APA/API}}$$

$$a_{decel.}[\text{increments/sampling time}^2] = K13 \cdot \frac{K15}{65536 \cdot Z_{APA/API} \cdot (341\ \mu s)^2} = \frac{K17 \cdot 131\ s^{-2}}{Z_{APA/API}}$$

Below are some examples of accel./decel. values specified in common units:

a) Accel./decel. in [1/s^2]

$$K13 = \frac{Z_{APA/API}}{131\ s^{-2}}$$

b) Accel./decel. in [m/s^2]

$$K13 = \frac{Z_{APA/API}}{VK} \cdot 1000 = \frac{Z_{APA/API} \cdot 1000}{VK \cdot 131\ s^{-2}}$$

c) Accel./decel. in [mm/s^2]

$$K13 = \frac{Z_{APA/API} \cdot i}{VK} = \frac{Z_{APA/API}}{VK \cdot 131 s^{-2}}$$

Note

You cannot enter values < 1 . If you have calculated a value < 1, you have to use a different unit (e.g. [m/s^2]).

With the parameter K13 defined, all parameters relating to acceleration are to be specified in the selected unit.

Examples for calculating the scaling parameters K10 … K13

Condition: drive configuration as in fig. 16 on page 36 where

Z = 1024 incr. d = 0.1 m i = 5

$Z_{APA/API}$ = Z · 4 = 4096 VK = d · π

Calculating the distance units

Unit	Formula	Value (given the above)
Increments	K10 = 1 K11 = 1	K10 = 1 K11 = 1
Output in [mm]	K10 = Z · 4 · i K11 = d · π · 1000	K10 = 20480 K11 = 314
Output in [rev.] (reduced to motor)	K10 = Z · 4 K11 = 1	K10 = 4096 K11 = 1
Output in [rev.] (reduced to gear unit)	K10 = Z · 4 · i K11 = 1	K10 = 20480 K11 = 1
Output in [degrees] (reduced to motor)	K10 = Z · 4 K11 = 360	K10 = 4096 K11 = 360

Calculating the speed units

Unit	Formula	Value (given the above)
Output in [m/min]	$K12 = \frac{Z \cdot 4 \cdot i \cdot 22.35}{d \cdot \pi \cdot 60}$	K12 = 24281
Output in [mm/s]	$K12 = \frac{Z \cdot 4 \cdot i \cdot 22.35}{d \cdot \pi \cdot 1000}$	K12 = 1457
Output in [1/min] (reduced to motor)	$K12 = \frac{Z \cdot 4 \cdot 22.35}{60}$	K12 = 1526
Output in [1/s] (reduced to gear unit)	$K12 = \frac{Z \cdot 4 \cdot i \cdot 22.35}{1}$	K12 = 457682

Calculating the accel./decel. units

Unit	Formula	Value (given the above)
Output in [m/s^2]	$K13 = \frac{Z \cdot 4 \cdot i}{d \cdot \pi \cdot 131\ s^{-2}}$	K13 = 497
Output in [1/s^2] (reduced to gear unit)	$K13 = \frac{Z \cdot 4 \cdot i}{1 \cdot 131\ s^{-2}}$	K13 = 156

3.2.3.2 Determining travel specific parameters

Maximum speed (K14)

Unit: Speed unit as defined in K12 (see section 3.2.3.1)
This parameter defines the maximum possible speed of an axis.
If a higher speed is programmed in a travel command, it will be replaced by this parameter.

Accel./decel. type (K15)

0 : linear
1 : $\sin^2$ pattern (s-curve)
This parameter determines the type of accel./decel. ramp.

Maximum acceleration (K16)

Unit: Accel./decel. unit as defined in K13 (see section 3.2.3.1)
This parameter defines the maximum possible acceleration of an axis.

Maximum deceleration (K17)

Unit: Accel./decel. unit as defined in K13 (see section 3.2.3.1)
This parameter defines the maximum possible deceleration of an axis.

Rapid feed (K18)

Unit: Speed unit as defined in K12 (see section 3.2.3.1)
This parameter determines the rapid feed rate in the jogging mode.

Creep feed (K19)

Unit: Speed unit as defined in K12 (see section 3.2.3.1)
This parameter determines the creep feed rate in the jogging mode.

Zero offset (K20)

Unit: Distance unit as defined in K10 and K11 (see section 3.2.3.1)

This parameter offsets the machine zero from the home position. After a completed reference travel or after execution of the SET 0 command the home position or the actual position are set to the value of the zero offset.

Positive software limit switch (K21), negative software limit switch (K22)

Unit: Distance unit as defined in K10 and K11 (see section 3.2.3.1)

These two parameters are used to define the travel limits. They must be placed before the corresponding hardware limit switches. If the resulting target position of a travel command is outside these limits, the positioning will not be carried out and a fault signal generated.

With continuous travel, the axis is stopped and a fault signal is generated when a software limit switch position is overrun.

To avoid generation of a fault signal in continuous travel, the two parameters K21 and K22 are set to "0". Then the software limit switches are not monitored and, consequently, no fault signal generated.

Lag error tolerance (K23)

Unit: increments

The lag error tolerance is the maximum permissible deviation between the actual position and the target position. If this tolerance is exceeded the position control of the positioning module is switched off a setpoint of 0 output to the speed controller and a fault signal generated.

Position window (K24)

Unit: increments

This parameter serves to determine when a travel command without resumption of program execution is (GOW ...) completed. The actual position is constantly compared with the target position until the difference is less than K 24 allowing program execution to continue (see section 3.2.2 "Output terminal X11/23: axis in position").

Important:

With very small position windows and poorly set speed or position controllers the axis may overshoot the target position. If in such a case the axis leaves the position window, the signal "axis in position" will be low as long as the actual position remains outside the position window. The signal will also be reset if the axis is moved out of position while the "controller inhibit" is active.

Polarity encoder (K25)

0 : positive
1 : negative
This parameter permits operation of an incremental encoder where the channels A, $\overline{A}$, and B, $\overline{B}$ have been switched, without changing the connections.

Important:

If parameter K25 is set incorrectly, the axis will accelerate in the wrong direction. When the max. lag error tolerance is exceeded, fault message F42 (lag error) is generated and the drive switched off.
When the drive is commissioned, the lag error tolerance should therefore be set to no more than half a motor revolution (2048 increments for encoders with a resolution of 4096 ppr).

If the axis immediately indicates a lag error fault, then reverse the polarity of the encoder (K25 = negative).

When the encoder simulation of the axis module is used and the connection to the APA 12/API 12 is correct, this parameter need not be changed. The default setting is always "positive" for the channel sequence A, $\overline{A}$ - B, $\overline{B}$.

$\sin^2$ form factor acceleration (K26), $\sin^2$ form factor deceleration (K27)

Unit: Accel./decel. unit as defined in K13 (see section 3.2.3.1)
Condition: K15 = 1
These parameters determine the curve of the $\sin^2$ pattern in the acceleration phase (K26) and the deceleration phase (K27). The specified values correspond to the absolute value of the linear acceleration component 5 ms after the beginning of the acceleration or deceleration phase (see schematic). I.e. if the

drive were to accelerate in a linear fashion with the acceleration specified by form factors K26 and K27 the acceleration value of K26 or K27 would be reached 5 ms after the beginning of the acceleration phase.

The phase length of the sin^2-type curve depends on the form factors K26 and K27, the maximum accel./decel. values K16 and K17 and the travel command. It is maximum 500 ms. The system will go into constant acceleration:

– either after the maximum acceleration/deceleration K16 or K17 has been reached

– or after the maximum phase length of 500 ms. The maximum acceleration/deceleration values are not reached in this case.

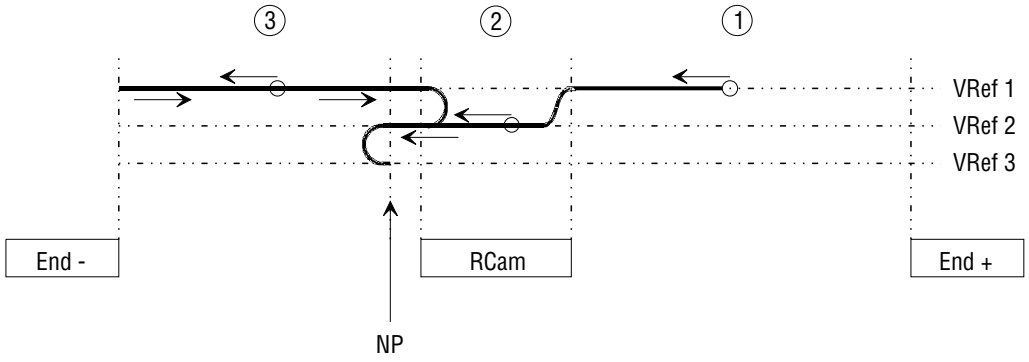


Fig.17: Effect of sin 2 form factors K26 and K27 on the acceleration and deceleration phases 00022AEN

Important:

As the effect of form factors K26 and K27 depends on the setting of K16 and K17, we recommend setting the values of K16 and K17 as high as possible.

STOP

Note on the sin^2 type-acceleration:

Note:

If these sin^2 form factors or machine parameter K15 are changed by SET K commands, remember that they will only be active for the first positioning movement after an executed axis standstill (e.g. after WAIT ST).

Caution: After a GOW command, the axis, depending on the size of the selected position window, may still continue travelling.

– The values of machine parameters K26 and K27 cannot exceed the values specified in K16 and K17 respectively. Should this be the case, the positioning module will set them to the values of K16 and K17 respectively.

– The values programmed in machine parameters K16, K17, K26 and K27 are maximum values (100% values). They can be modified in the program (1 ... 100%) with SET commands.

  The maximum value programmed in the machine parameters remains unchanged though.

  e.g.: **`SET K16 = 50`** means:

  Set the linear acceleration to 50% of the maximum value specified in machine parameter K16.

  After the positioning module is switched on and after the transfer of the machine parameters, these factors are set to 100%.

– Linear acceleration and sin^2-type deceleration (and vice versa) is possible by setting K15=1 and K16=K26 or K17=K27.

  With different acceleration and deceleration values, it should be ensured that the respective parameters for acceleration and deceleration do not differ too much. (Extreme case: very high linear acceleration and weak sin^2-type deceleration can cause unsteady speed patterns during deceleration.)

– The reference travel can also be performed with sin^2-type accel./decel. if selected. Unlike linear accel./decel. when the direction of travel is reversed, the axis is first stopped in a sin^2-type pattern and will then continue in the opposite direction in a sin^2-type pattern.

– The new calculation of the accel./decel. ramps initiated by a SET K command (15, 16, 17, 26, 27) is complex and can lead to delays in program execution of approx. 50 ... 60 ms.

– If setting sin^2 factors in the program via variables, the sin^2 factors can be changed via the serial interface while the program is running.

– When the feed enable is removed, deceleration is always linear for safety reasons. When the feed enable is reapplied, the acceleration is sin^2-type, as is the travel motion thereafter.

– A change of speed via the override has no effect during sin^2-type travel. The change will only be accepted following an axis standstill.

Encoder type

– incremental
– SSI (only APA 12)

When selecting an SSI encoder, the encoder selection list is automatically displayed. If the required encoder is not included in the selection list, first set the encoder parameters and then add it to the list (→ Sec. 2.4 “Setting the encoder parameters”).

Reference position (K55) (only APA 12)

When an absolute encoder is installed, the encoder zero must always be calibrated with the machine zero. This is usually done by mechanical adjustments or using initialization inputs in more modern encoders. Parameter K55, used in conjunction with K20 (zero offset), now makes the task more straightforward. The reference position allows the positioning control to calculate the distance to the mechanical encoder zero (encoder position value = 0) independently, thereby defining a new encoder curve. The following diagrams illustrate this process.

Using parameters K55 (reference position) and K20 (zero offset)
Example: Encoder AGY 100 (4096 · 4096, max. position 16777216)

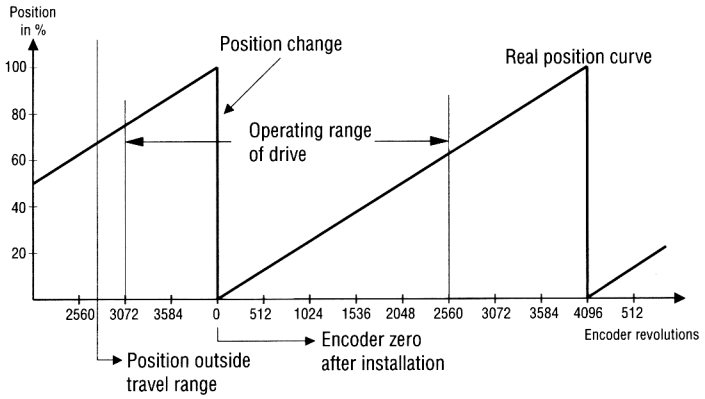


Fig. 18 MD001AEN

The use of parameter K55, however, causes the encoder "zero" and also its position offset to be displaced.

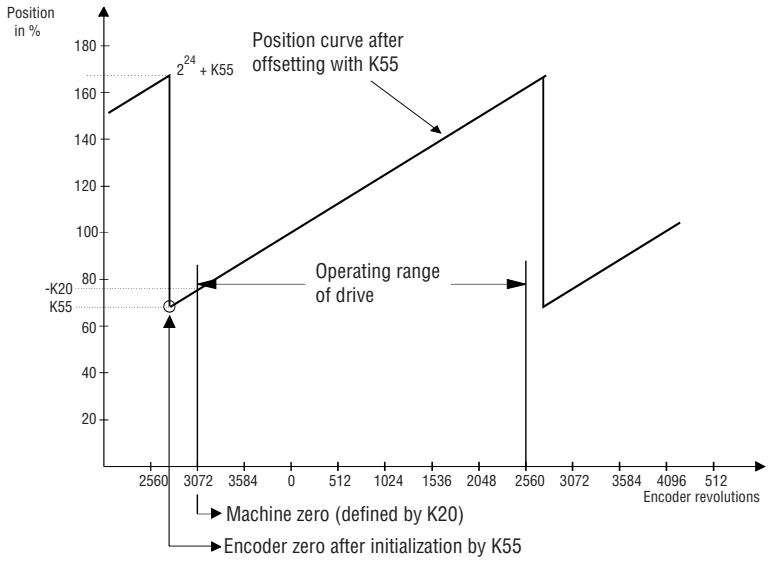


Fig. 19 MD0011AEN

Parameter K20 (zero offset) can now be used to equalize the position offset, and the machine zero can be defined.

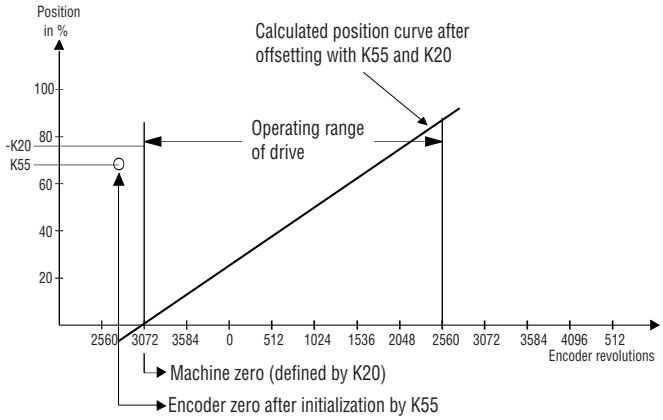


Fig. 20 MD0012AEN

SSI position sign (K56) (only APA 12)

The sign must be set after the SSI module in order to perform position calculations.

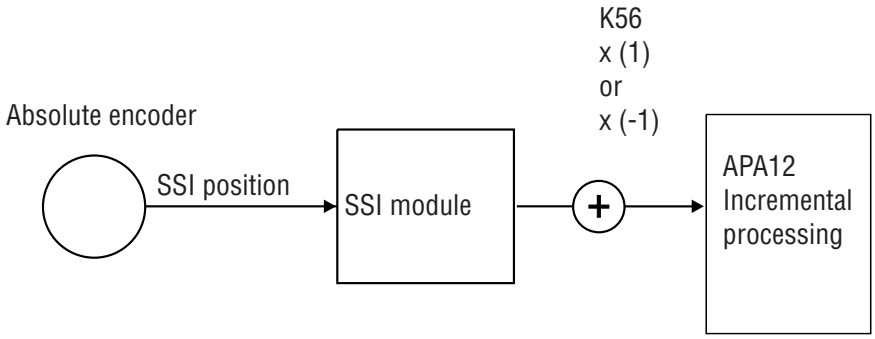


Fig. 21 MD0013AEN

When the equipment is first switched on, the position of the encoder is read directly. Subsequent encoder movement is passed to the APA 12 as signed increments. It is therefore possible for the encoder to be incrementing its position, whereas the APA 12 decreases the position internally.

As the direction of rotation of the encoder depends on where it is installed, the direction must be defined after installation. When the SSI module is switched on, it reads the absolute position of the encoder, and afterward only passes the difference between the positions to the control system as pulses. The interpretation of the sign is determined by parameter K56. The correct setting is defined as follows:

Where the revolutions of the encoder and the position increase, the sign must be positive (with certain encoder types different definitions are used or can be set).

Important:

Because of the immediate relationship between K25 (polarity encoder) and K56 (SSI position sign) both parameters must always be set the same.

increasing revolutions - increasing position	K25 = K56 = positive
decreasing revolutions - decreasing position	K25 = K56 = negative

3.2.4 Reference travel parameters

Reference travel type (K30)

Value range: 0 ... 8

Depending on the position of the reference cam and the encoder zero pulse to be evaluated, different reference travel types can be selected.

The absolute encoder causes functional differences in the **reference travel** function for the APA 12. The travel procedure remains the same, there is no zero travel however (i.e. no VRef 3). When the reference cam is reached, the axis is stopped and the absolute position, offset by K20 (zero offset), is displayed.

Explanation of the reference travel type figures

Possible starting positions:

① between reference cam and positive limit switch

② at the reference cam

③ between reference cam and negative limit switch

Explanation of the abbreviations used in the figures:

End -	negative hardware limit switch
End +	positive hardware limit switch
RNok	reference cam
NP	zero pulse
VRef 1	first reference travel speed (see K32)
VRef 2	second reference travel speed (see K33)
VRef 3	third reference travel speed (see K34)

Type 0

No reference travel is performed.

Instead the current position is set to the value of the zero offset (also see command SET 0: see section 7.3.2.3).

The APA 12 retains the current position and there is no zero offset.

Type 1

The reference cam is located between the two hardware limit switches; the zero pulse to be evaluated shall be the first pulse after leaving the cam in the negative direction of travel.

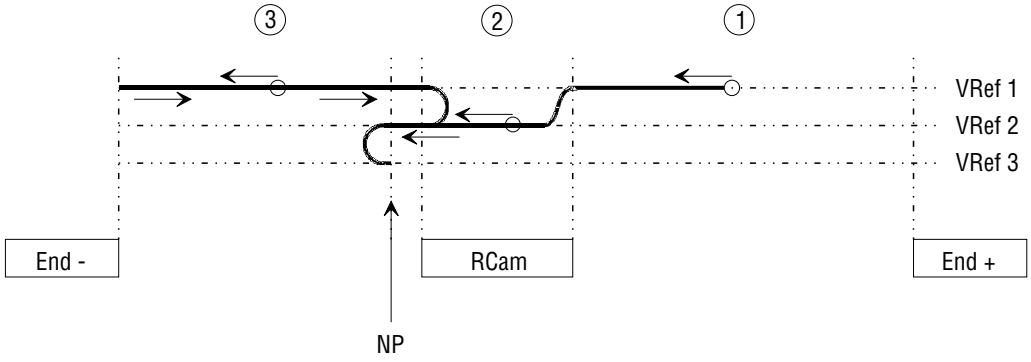


Fig. 22 00023AEN

Type 2

The reference cam is located between the two hardware limit switches; the zero pulse to be evaluated shall be the first pulse after leaving the cam in the positive direction of travel.

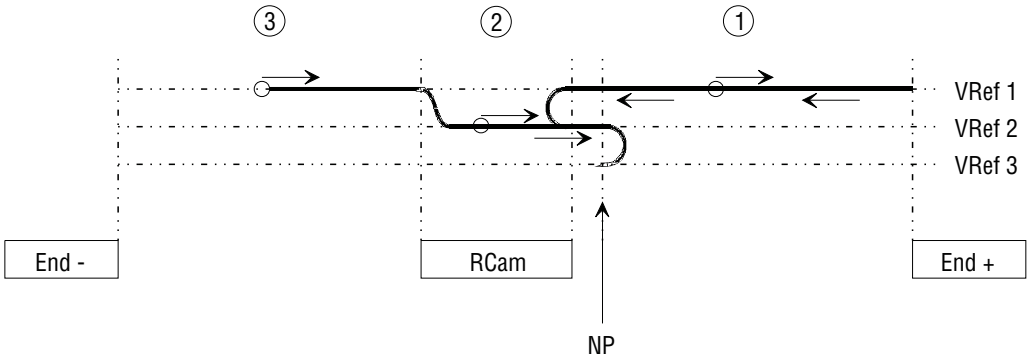


Fig. 23 00024AEN

Type 3

The reference cam is located between the two hardware limit switches; the zero pulse to be evaluated shall be the first pulse after reaching the cam in the positive direction of travel.

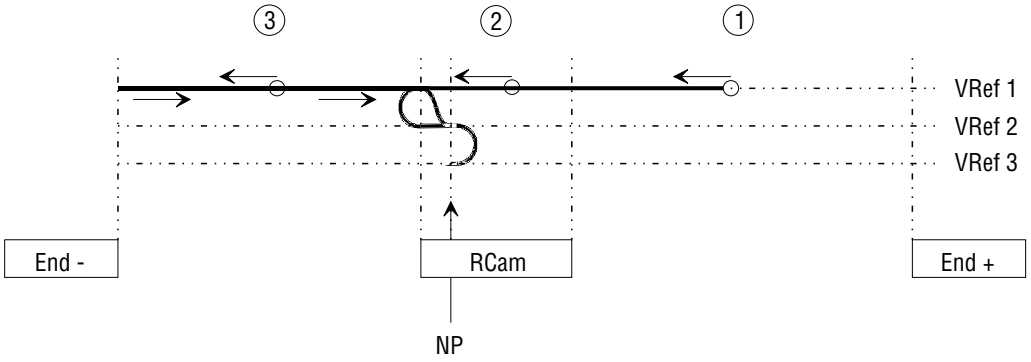


Fig. 24 00025AEN

Type 4

The reference cam is located between the two hardware limit switches; the zero pulse to be evaluated shall be the first pulse after reaching the cam in the negative direction of travel.

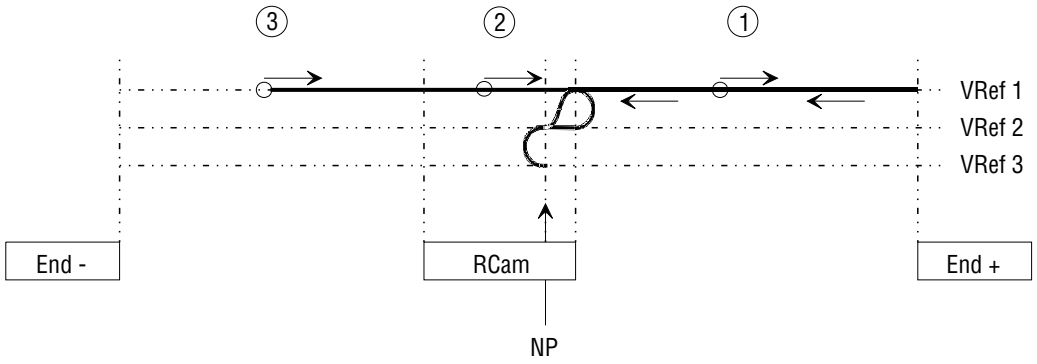


Fig. 25 00026AEN

Type 5

The reference cam is level with the negative hardware limit switch; the zero pulse to be evaluated shall be the first pulse after reaching the cam in the negative direction of travel.

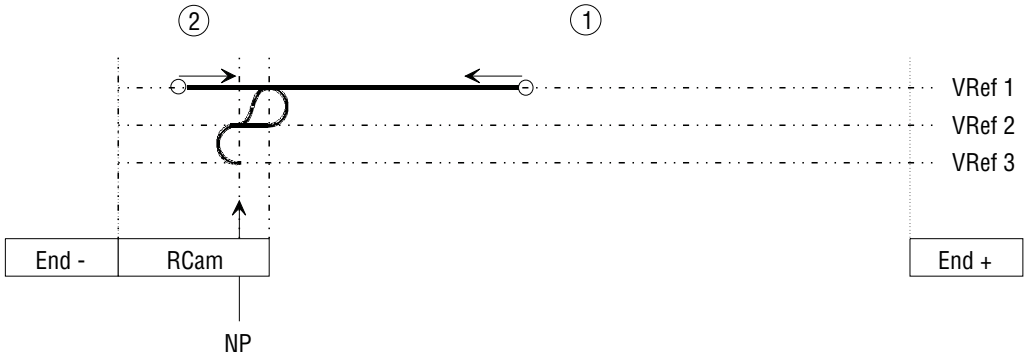


Fig. 26 00026AEN

Type 6

The reference cam is level with the positive hardware limit switch; the zero pulse to be evaluated shall be the first pulse after reaching the cam in the positive direction of travel.

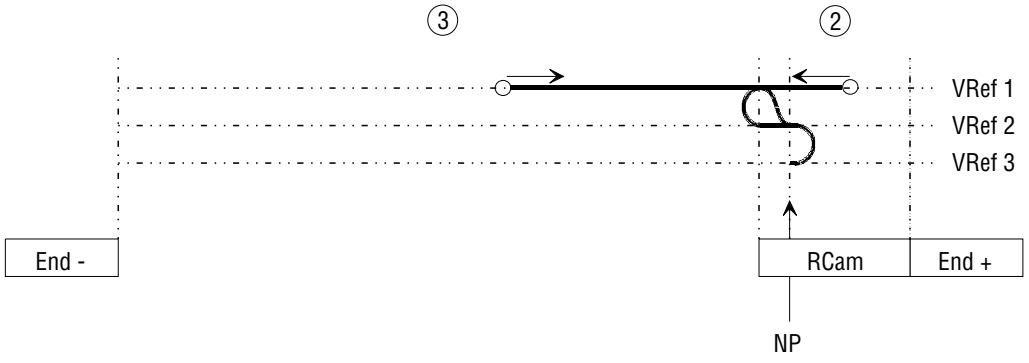


Fig. 27 00028AEN

Type 7

The reference cam is level with the negative hardware limit switch; the zero pulse to be evaluated shall be the first pulse after leaving the cam in the positive direction of travel. If no reference cam is available, place a jumper between the hardware limit switch and the reference cam in order to perform a reference travel.

When doing so, please note the following:
As the polarity of the hardware limit switch and the reference cam is different, the polarity of the reference cam (K31) must be programmed to be negative. To prevent the axis from returning to the limit switch after leaving it, reference travel speed 3 (VRef 3, K34) must be set to zero. After the axis has stopped, its relative position to the zero pulse or the zero offset is displayed.

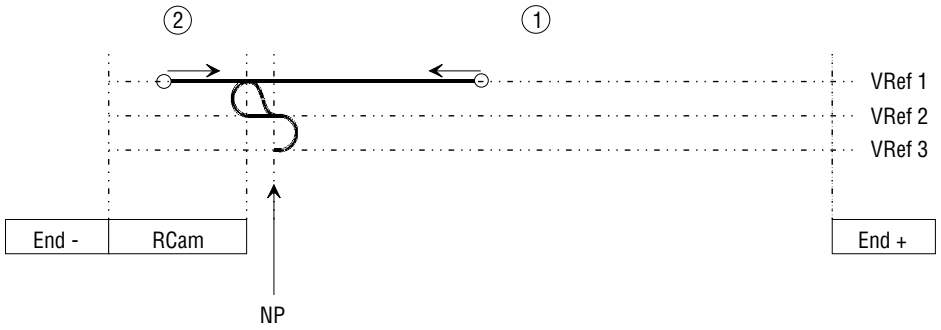


Fig. 28 00029AEN

Type 8

The reference cam is level with the positive hardware limit switch; the zero pulse to be evaluated shall be the first pulse after leaving the cam in the negative direction of travel. If no reference cam is available, place a jumper between the hardware limit switch and the reference cam in order to perform a reference travel.

When doing so, please note the following:
As the polarity of the hardware limit switch and the reference cam is different, the polarity of the reference cam (K31) must be programmed to be negative. To prevent the axis from returning to the limit switch after leaving it, reference travel speed 3 (VRef 3, K34) must be set to zero. After the axis has stopped, its relative position to the zero pulse or the zero offset is displayed.

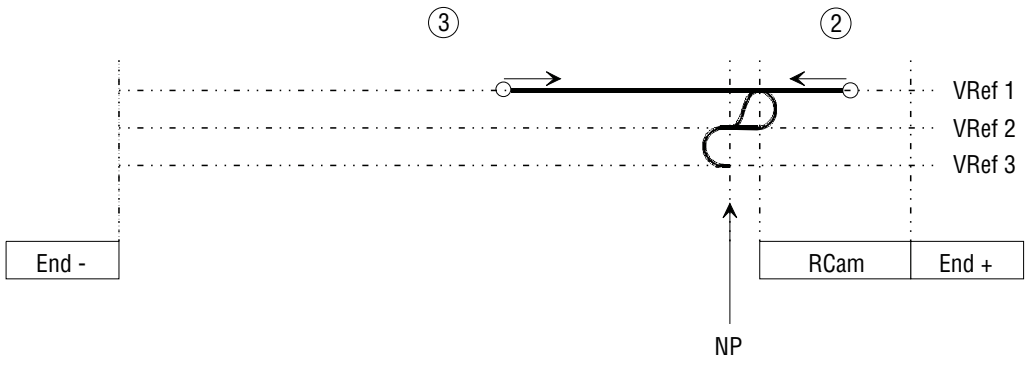


Fig. 29 00030AEN

Reference cam polarity (K31)

0 : low active (normally closed contact)
1 : high active (normally open contact)

VRef 1 first reference travel speed (K32)

Unit: Speed unit as defined in K12 (see section 3.2.3.1)

VRef 2 second reference travel speed (K33)

Unit: Speed unit as defined in K12 (see section 3.2.3.1)

VRef 3 third reference travel speed (K34)

Unit: Speed unit as defined in K12 (see section 3.2.3.1)

3.2.5 Control specific parameters of the position controller

P component (K40)

This parameter is used to define the proportional component of the position controller.

Value range: 0 ... 32767
Recommended range: 2 ... 8

The position controller is a proportional controller, much like the speed controller. The manipulated variable A generated by the position controller, if actual and target position deviate, serves as speed setpoint for the motor (see block diagram below). Position controller and speed controller mutually influence each other. To set the P component of the position controller, you need to optimize the speed controller beforehand (see section 2.4). The P component of the position controller may only be increased short of the drive starting to oscillate. We therefore recommend starting with a value of 2 and then increasing this value in several steps to determine the value where the drive starts oscillating. The P component entered as machine parameter (K40) must be smaller than the value thus determined.

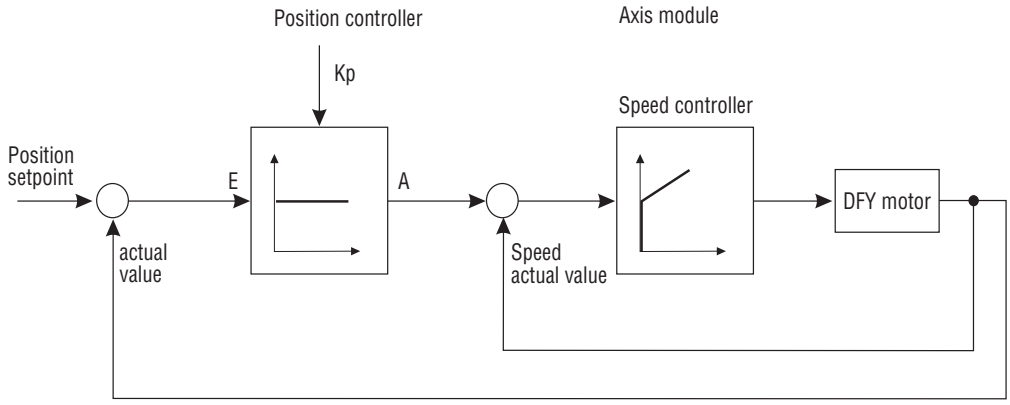


Fig. 30: Block diagram 00031AEN

For a more detailed block diagram see the MOVIDYN®Servo Controller Operating Instructions.

4 Working with the APA 12 / API 12

4.1 Switching on the APA 12/API 12 positioning control

Before continuing, make sure that the APA 12/API 12 single-axis positioning control is commissioned correctly and that the machine parameters are defined as required (see section 2).

- Switch on the MOVIDYN® Servo Controller.
- Unless you have already done so, connect a PC to the serial interface of the power supply module (for more detailed information see section 2).
- Start the MD_POS user interface (for more detailed information see section 2).
- To operate the APA 12/API 12, follow the instructions below.

4.2 Operating modes of the APA 12/API 12 positioning control

4.2.1 Overview of operating modes

The table below provides an overview of the different operating modes of the APA 12/API 12 and the corresponding levels and functions of the input terminals.

Operating mode	Input terminals X11/…							
	4 Automatic	**5** Start	**6** Feed enable	**7** Read-in enable	**8** Reference cam	**9** Jog +	**10** Jog -	**11** Touch probe
Reference travel	L	●	●	-	●	-	-	-
Jogging mode	L	L	●	-	-	●	●	-
Setting-up/Remote mode (Manual mode)	L	L	●	-	⇔	-	-	⇔
Automatic mode	H	●	●	●	⇔	-	-	⇔

Table: Operating modes

Symbols used:

L Low level
H High level
● active
- inactive
⇔ Whether the function of this input terminal is active depends on the action selected by the user.

4.2.2 Performing a reference travel

The reference travel serves to determine an absolute positioning reference (home position) for incremental measuring systems and is to be carried out once after power- up.

Different placements and evaluations of the reference cam and the zero pulse provide for different reference travel types (machine parameter K30, see section 3.2.4).

The selected reference travel type, the polarity of the reference cam and the reference travel speeds are specified in machine parameters K30 through K34 (see section 3.2.4).

The reference travel can be initiated in different ways:

- Via the input terminal X11/5 (start):

  Drive input X11/5 high.

  Requirements:

  - Input terminal X11/4 (automatic/manual) = L
  - Axis not in jogging mode,
    i.e. input terminal X11/9 (jogging mode +) = L
    and input terminal X11/10 (jogging mode -) = L

- Via the MD_POS user interface in the [Reference travel] menu:

  - Select the [Set-up] menu.
  - Select menu item [Reference travel].

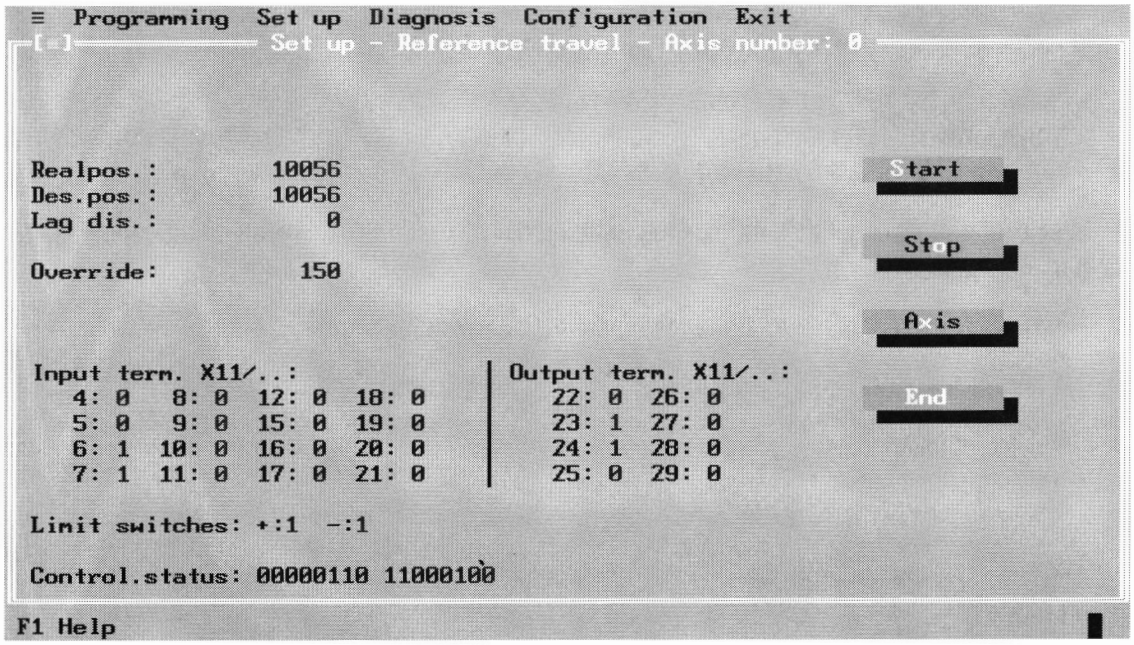

≡ Programming Set up Diagnosis Configuration Exit
[ ] Set up - Reference travel - Axis number: 0
Realpos.: 10056
Des.pos.: 10056
Lag dis.: 0
Override: 150
Start
Stop
Axis
End
Input term. X11/..:
4: 0 8: 0 12: 0 18: 0
5: 0 9: 0 15: 0 19: 0
6: 1 10: 0 16: 0 20: 0
7: 1 11: 0 17: 0 21: 0
Output term. X11/..:
22: 0 26: 0
23: 1 27: 0
24: 1 28: 0
25: 0 29: 0
Limit switches: +:1 -:1
Control.status: 00000110 11000100
F1 Help

Fig. 31 Reference travel menu 00032AEN

  - Select the [Axis] which is to perform the reference travel.
  - Select [Start].

  The reference travel will be performed.

- By entering the command GO 0 in a program (see section 7.1.4) or by entering this command in the [Command line] of the [Manual mode] menu.

The end of the reference travel - if configured in the machine parameters - is indicated by output terminal X11/24 (home position defined) = H. During the reference travel the function of input terminal X11/6 (feed enable) is activated.

The functions of the hardware limit switches differ depending on the type of reference travel selected (machine parameter K30, see section 3.2.4). During the reference travel an actuated limit switch, depending on the reference travel type, is used as reversal point in the search for the reference cam.

4.2.3 Jogging mode

In the jogging mode, set via input terminals X11/9 (jogging +) and X11/10 (jogging -) an axis can travel in both directions at the speeds defined in the machine parameters for rapid feed (machine parameter K18) and creep feed (machine parameter K19).

The table below shows the assignment of motion type and signal level at the terminals:

	Rapid feed negative [1]	Creep feed negative	Standstill	Creep feed positive	Rapid feed positive [1]
Jog+ (terminal X11/9)	H	L	L	H	H
Jog- (terminal X11/10)	H	H	L	L	H

Table: Motion types

1) Rapid feed travel is only possible if preceded by a creep feed motion in the desired direction. This will clearly determine the direction of the creep feed motion (positive or negative).

- To determine the direction of rotation select one of the two inputs. The drive will start rotating in the desired direction of rotation at the creep feed rate set in machine parameter K19.

  Requirements:

  - Input terminal X11/6 (feed enable) driven high
  - Input terminal X11/4 (automatic/manual) driven low
  - Drive must be at rest before starting.

- To select rapid feed, set the alternate jog input high. The drive will accelerate to the rapid feed set in machine parameter K18.

- To change from rapid feed to creep feed reset the alternate jog input low.

- End the travel motion by

  - driving both inputs low
  - resetting the input first operated.

Important

If you switch from standstill (L/L) immediately to input (H/H), the drive will not travel.

The axis will also stop during rapid feed travel if the terminal used for selecting creep feed is driven low.

4.2.4 Set-up/Remote mode (manual mode)

In this mode, the user can communicate with the APA 12/API 12 positioning control via the RS-485 or RS-232 interface using the MD_POS software. This mode allows you to edit and transfer some of the commands and machine parameters contained in the command set (see section 7.2).

Communication with the APA 12/API 12 is via the [Manual mode] menu option.

- Select [Set-up].
- Select [Manual mode].

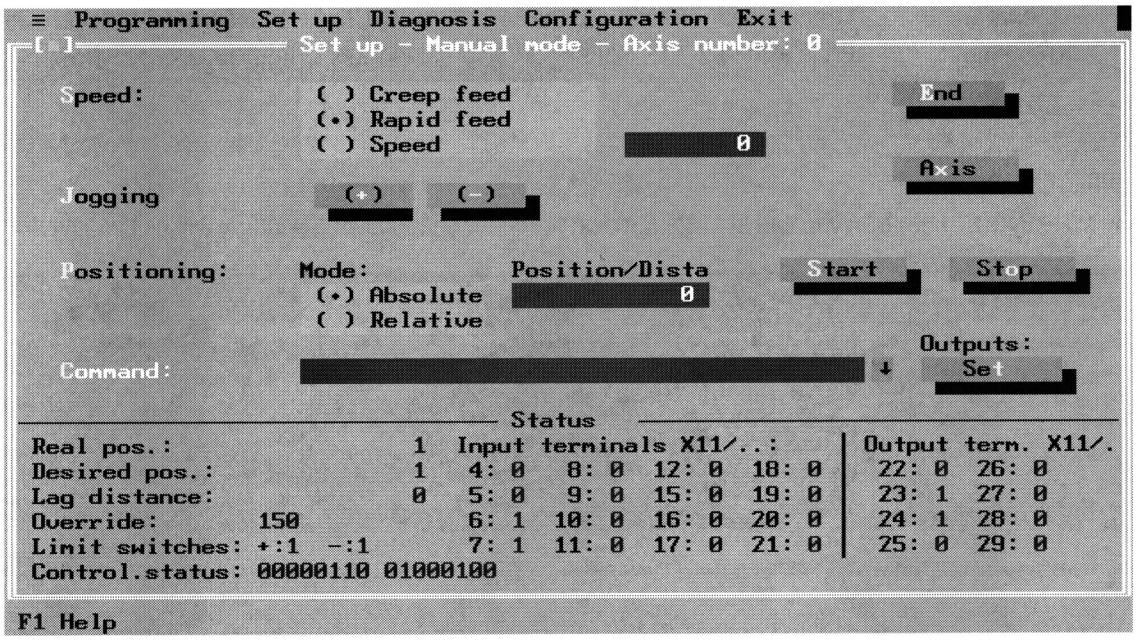


Fig. 32: Manual mode menu 00100AEN

Travelling in manual mode

There are three ways of travelling in manual mode:

- Select [Creep feed] or [Rapid feed] or enter a [Speed] and click on the [Jogging +] or [Jogging -] controls with the mouse. The axis will travel in the positive or negative direction as long the corresponding control remains activated.

  Unlike in the jogging mode the travel command is not given via input terminals X11/9 (Jog+) and X11/10 (Jog-), but via the serial interface.

  In this mode, be aware that the data transfer time of the serial will delay because of the response time of the drive.

or

- Enter a travel command in the [Command line] directly (see section 7.2).

or

- Select mode [Absolute] or [Relative] in the [Positioning] field, then enter a value in the [Position/Distance] field and click on the [Start] button.

When in manual mode you can enter the following commands (see section 7.2):

- Set commands
- Positioning and travel commands
- Data management commands

Jump and call instructions cannot be entered in the programming mode. These commands can only be used in the programs themselves.

- Select the [Command line] in the [Manual mode] menu.
- Enter the commands.
  The commands are transferred directly to the APA12/API 12 via the serial interface. The corresponding function is executed immediately after pressing the <Return> key.

Important:

By clicking the [ ] control, you can activate a repeat function. The following window will be displayed:

Fig. 33 Repeat function for commands in manual mode 00101AEN

Select the desired command and double-click on it. This will enter it in the [Command line] where it can be executed again.

Example:

If you want to enter a travel command:

GO A250 V100 (250 = absolute distance to travel in distance units, 100 = speed in speed units)

If you want to view a table position:

%RD TXX (xx = table position index)

Message (acknowledgement):

TXX:A (a = entered position value)

If you want to change the maximum speed (parameter K14):

%K14:B (b = new speed value)

For a more detailed discussion of these examples as well as the different ways of entering commands see:

→ section 7.2, "Command sets for manual mode"

→ section 3, "Machine parameters"

Set outputs

The program also allows you to set outputs for test purposes (e.g. to check PLC functions).

- Click [Set outputs].

The following window will be displayed:

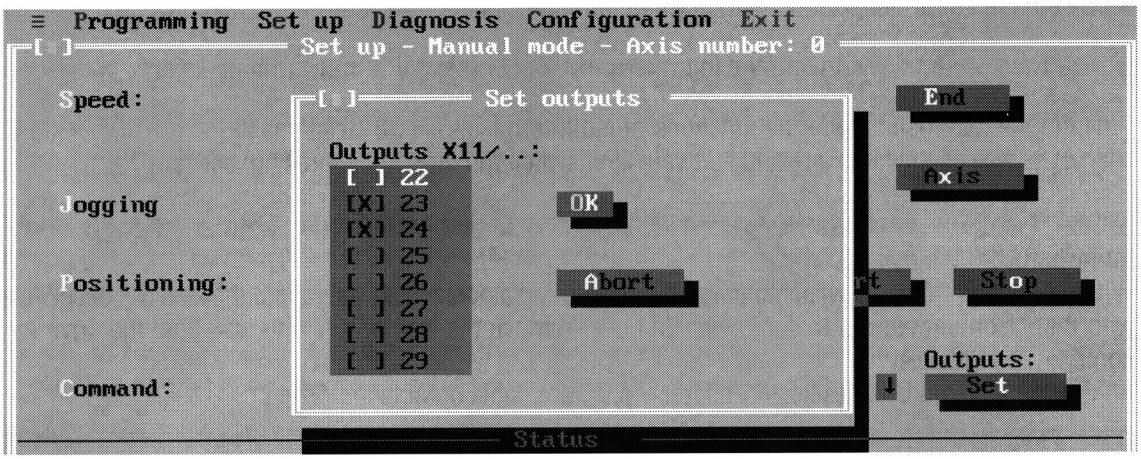


Fig. 34: Setting outputs in manual mode 00102AEN

- Drive the desired inputs high by [X]-ing them and click [OK] to confirm.

Note

Outputs which are permanently assigned a function in the machine parameters cannot be changed via this window. Any entries made will be ignored. To accept entries confirm by clicking [OK].

4.2.5 Automatic mode

In the automatic mode, a program stored in the positioning control is started via input terminal X11/5 (start program). The program lines are executed in sequence until the end of the program is reached.

The number of the program to be started can either be selected via the digital inputs or predefined in the machine parameters (see section 3).

- Select the automatic mode by driving the input terminal X11/4 (automatic/manual) high.
- Start the program by driving the input terminal X11/5 (start program) to high level.

When in the automatic mode the functions of input terminals X11/6 (feed enable) and X11/7 (read-in enable) as well as the hardware and software limit switch monitoring features are active.

Important:
When switching from automatic to manual mode during a positioning operation, the axis will decelerate with the maximum current; before switching over remove the feed enable and wait until the drive has come to a complete stop.
If the automatic mode is deselected, all freely programmable outputs are reset.

4.3 Editing machine parameters

There are two ways of editing the machine parameters:

- editing via the [Machine parameters] menu

or

- editing via the [Manual mode] menu

Editing in the machine parameters menu

Caution !

Parameters in the machine parameters menu may only be edited when the axis is not travelling.

- Select the [Programming] option of the main menu.
- Select [Machine par.].
- Specify where the data are to be retrieved from:
  - Select [Disk] if the machine parameters to be edited are saved on the hard disk of your PC.

  or

  - Select [Axis] if you want to edit the machine parameters of a positioning module (APA 12/API 12).

- Call the appropriate menu pages (the machine parameters are listed on four pages (screen menus) see section 2.3).
- Edit the machine parameters (see section 3).
- Save the new parameters to the axis.
  Please read the notes on 'Saving data' (see section 4.5).

Editing in the manual mode menu (programming mode)

- Select [Set-up] in the main menu.
- Select [Manual mode].
- Enter the corresponding commands in the [Command line] (see section 4.2.4).
- To save the new parameters to the axis select the "Store data" option. Please read the comments on saving data (see section 4.5).

4.4 Entering programs

To enter new programs for the positioning control or customize existing programs for a particular application:

- Select [Programming] from the main menu
- Select [Program].
  You will be prompted to specify where the data are to be retrieved from. The program offers you three choices:
  - Select [New] if you want to enter a completely new program.
  - Select the [Axis] option if you want to edit a program stored in the APA 12/API 12.
  - Select [Disk] if you want to edit a program which is stored on the hard disk of the PC.
- Enter new programs or edit existing programs (see section 7.1).
- Save the new or edited program to the [Axis] and/or [Disk]. Please read the comments on saving data (see section 4.5).

Important:

Any attempt to transfer a program to the axis while in automatic mode will generate an error message.

4.5 Saving data

The MD_POS software has several levels and options of saving data.
These are:

- Storing axis data in the non-volatile memory (flash EPROM) of the APA 12/API 12.

  Select [Store data] in the [Programming] menu to store all axis data (machine parameters, travel programs, variables and table positions) in the non-volatile memory (flash EPROM) of the APA 12/API 12. These data are stored in the memory when the unit is powered off and are available again when the MOVIDYN® Servo Controller is powered up. The axis data are automatically loaded from the flash EPROM to the main memory of the APA 12/API 12 when the unit is powered up.

  Remember to save your data before you switch off the unit whenever you have edited existing data records or created new ones. MD_POS has a built-in safeguard reminding you that you have edited data and not saved them yet and will ask you whether you want to save your changes before exiting.

- Saving programs to the hard disc of the PC

  If you want to save data to the hard disc of your PC select the [Program] menu option. With new programs select menu item [Save as ...] with existing programs select menu item [Save]. The Save feature is assigned to the F2 function key, allowing you to quick-save your program during programming sessions. Your old program will be overwritten by the new version currently being edited.

- Saving axis data to the hard disc of a PC

  To save your data select the [Disk] option in the selection box of the menu you are in. Remember that only the data you have edited in the respective menu item will be saved. Data thus saved are not available to the positioning control. If you want these data to be available to the positioning control you additionally need to save them to the [Axis] (see above).

- Saving data to a diskette

  If, in addition to the above save options, you wish to backup data records (programs, machine parameters, etc.) on a diskette, you may do so using MS DOS commands at the operating system level of your PC or by typing the full pathname in the save to [Disk] option menu discussed above.

Note

Saving axis data in the main memory (RAM) of the APA 12/API 12 does mean you have actually stored them. The saving process is started when you select the [Axis] field in the selection box. This will only save the data which you have edited in the respective menu option. These data are immediately available to the axis, they are however lost when the unit is switched off. Use the [Store data] option to write the program(s) and machine parameters to the non-volatile memory of the APA 12/API 12.

4.6 Exiting MD_POS

Note

The APA 12/API 12 positioning module is not deactivated when you exit the MD_POS user interface.

- Select [Exit] in the main menu if you are finished with MD_POS and want to exit the application.

  You will be asked:

Fig. 35: The "Exiting the TERMINAL program" mask 00103AEN

- Remember to store your data before exiting the program (see section 4.5).
- Select [Yes].
  MD_POS will be closed and you return to the MD_SHELL level. If you have edited data records without saving them, a window will prompt you to do so.
- If you do not want to exit the program select [No].
  You will remain in MD_POS.

5 Service Information

5.1 Diagnosis menu

The diagnosis menu of the MD_POS user interface offers several ways of monitoring the positioning control (status monitoring) and keeps a log of all faults.

- Select [Diagnosis].
  The [Diagnosis] selection window will appear.

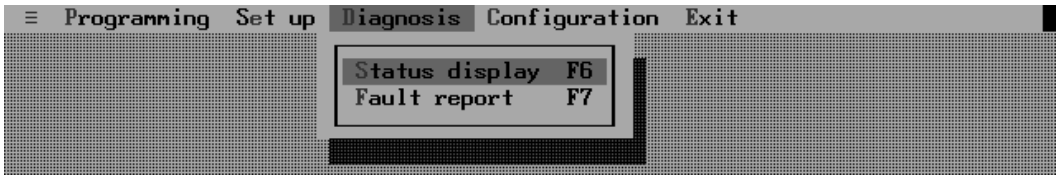


Fig. 36 Diagnosis menu 00104AEN

[Status display]

The [Status display] menu informs about the status of the electronic single-axis positioning control.

- For information about the status of the control select [Status display] (see section 5.2).

[Fault report]

The [Fault report] menu provides a list of all faults in the order of their occurrence.

- For information about faults that have occurred select [Fault report] (see section 5.3).

5.2 Status display

On selecting the [Status display] menu the following submenu appears:

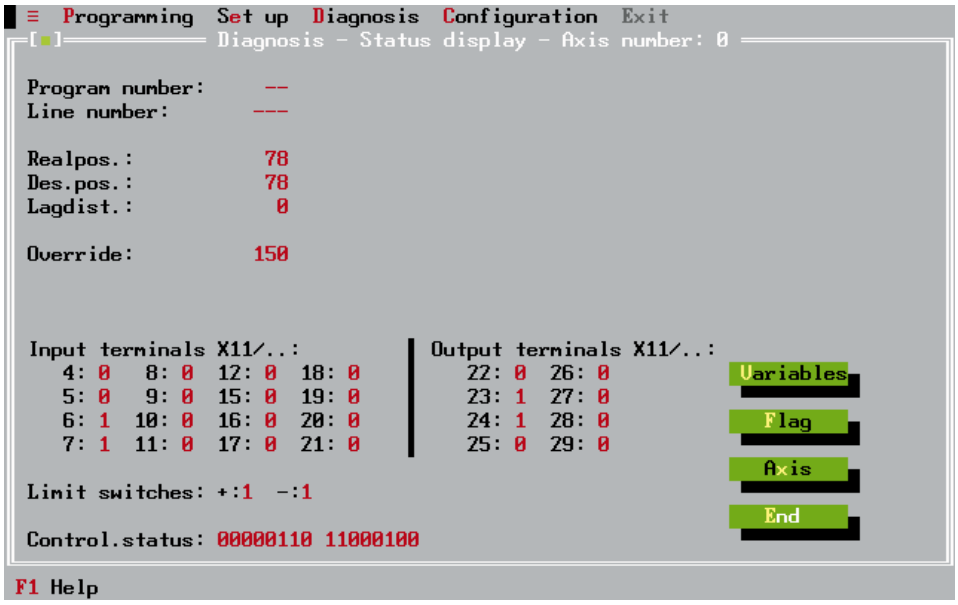


Fig. 37: Status display submenu 00105AEN

- Select the axis whose status you want to have displayed.
  Select [Axis].
  A window will appear prompting you for the axis number.

- Enter the desired axis number.
  The data of the selected axis will appear in the display.

The status data are continuously updated.

The screen provides the following information:

Designation	Display	Value
Program number	Program being executed	Pxx
Line number	Program line being executed	Nxxx
Actual position	Actual position of the axis	Distance unit
Target position	Position to travel to	Distance unit
Lag distance	Current lag distance	Increments
Override	Current override value	% of the setpoint speed
Input terminals	Status of input terminals X11/4 through X11/21	0 or 1 (low or high level)
Output terminals	Status of output terminals X11/22 through X11/29	0 or 1 (low or high level)
Limit switches	Status of limit switches (+, -)	1 = activated , 0 = not activated
Controller status	Internal controller status (this readout is not needed for normal operation, it is for service purposes only)	-

Flags

The travel programs allow for the use of flags. Flags are variables which can only have two values: 0 or 1 (low or high level). Flags are set and/or their status read by the program. A maximum of 100 flags can be set (see section 7.2.2.9).

The [Status display] menu provides the ability to view the status of the flags. You can have a maximum of 8 flags displayed on-line.

To check the status of a flag:

- Select [Flags].
  The following window will appear.

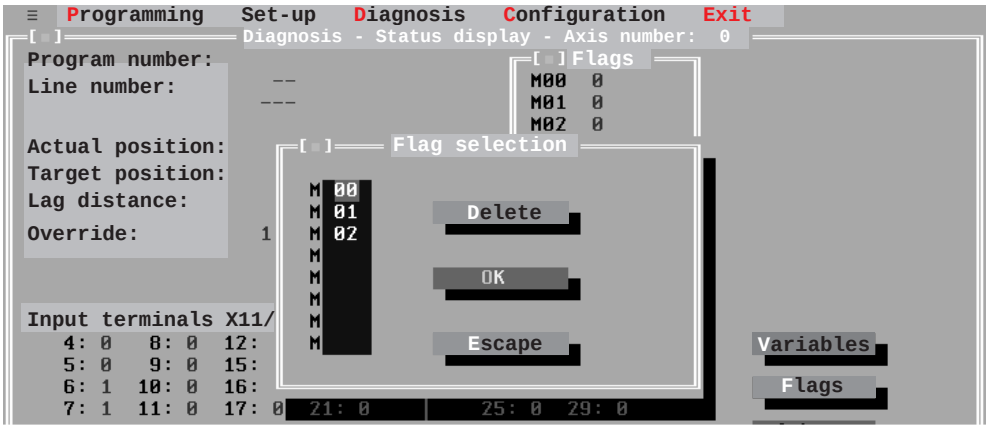


Fig. 38: Status display menu with flag selection window 00106AEN

- Enter the number of the flags you want to view on-line.
- Click the [OK] button to close the window.
  The selected flags are now continuously updated in a new window.

All flags are set to 0 on power-up.

Variables

The travel programs allow for the use of variables.

Variables are set and/or their status read by the program. A maximum of 100 variables can be set (see section 7.2.2.10).

The [Status display] menu provides the ability to view the status of the variables. You can have a maximum of 8 variables displayed on-line.

If you want to check the status of the variables:

- Select [Variables].
  The following window will be opened.

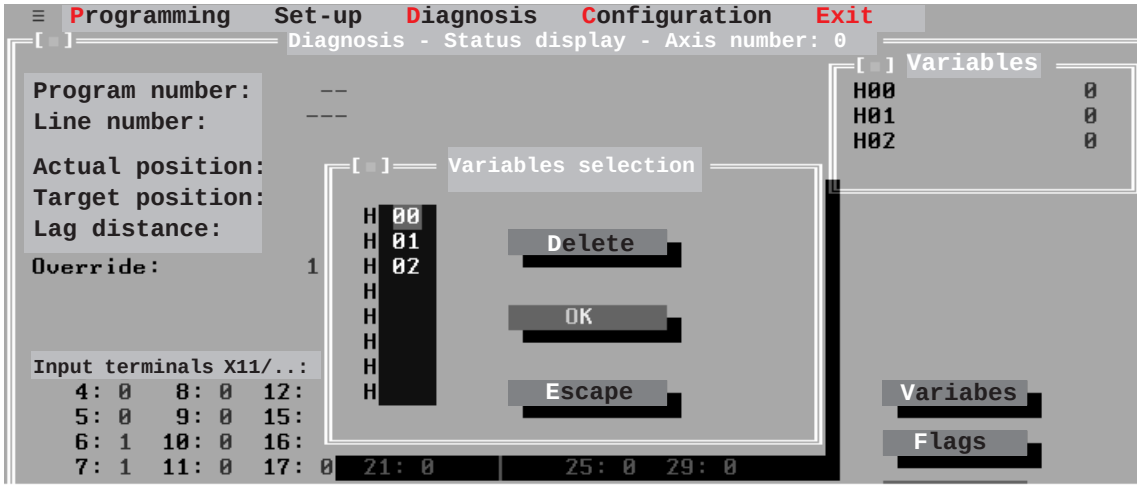


Fig. 39: Status display menu with variable status window 00107AEN

- Enter the number of the variables you want to view on-line.
- Click the [OK] button to close the window.
  The selected variables are now continuously updated in a new window.

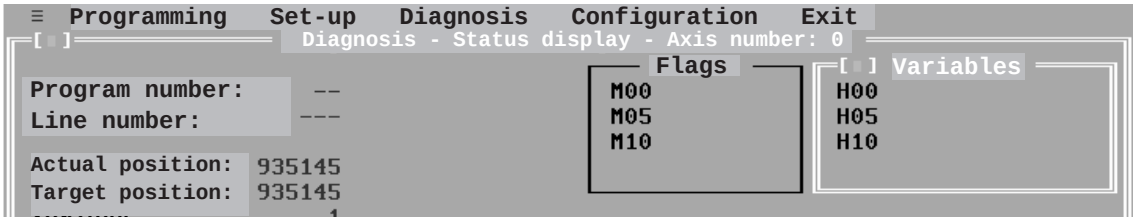


Fig. 40: Status display menu with on-line windows 00108AEN

5.3 Fault report

On selecting the [Fault report] menu the following will appear:

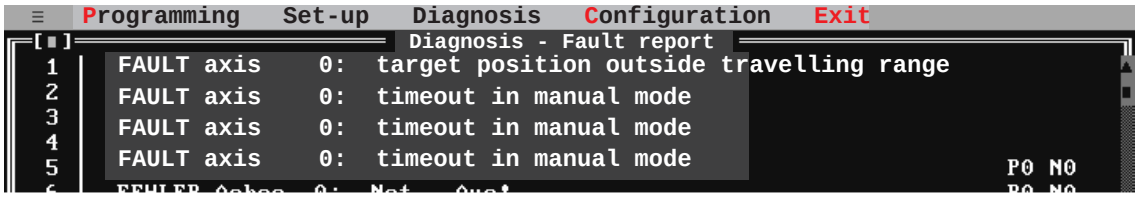


Fig. 41: Fault report 00109AEN

The fault report lists all faults which have occurred since the unit was powered up in the order of their occurrence. The fault which occurred last appears in the top line.

The fault messages are not stored, they are lost when the unit is switched off. Programming errors (PC) are not listed in the fault report.

Fault signals from the APA 12/API 12 are also passed to the MOVIDYN® Servo Controller and displayed in MD_SHELL.

Faults, which do not occur while on-line with the MD_POS interface are not recorded. They can be called from the fault memory of MD_SHELL.

All fault signals listed in section 5.5.2 are displayed and included in the fault report.

- Press the <Esc> key to exit the fault report.

5.4 Status report

When the axis is in operation, MD_POS provides status information about certain ongoing operations. This information is displayed in a window.

The status report will disappear when the operation it refers to is completed (e.g. data transfer). Status reports do not require operator input or response.

Example:

Status report during data transfer

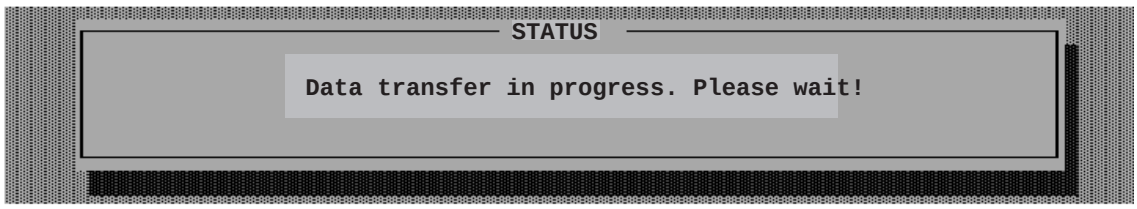


Fig. 42: Data transfer status report 00110AEN

5.5 Fault messages / Fault elimination

5.5.1 Fault messages

MD_POS outputs a fault message in the event of malfunctions and faults. These messages are displayed in a window.

As a rule, fault messages need to be cleared (see section 5.5.3).

All faults which occur during operation are written to a fault report buffer, which can be viewed for purposes of fault evaluation (see section 5.3).

Example:

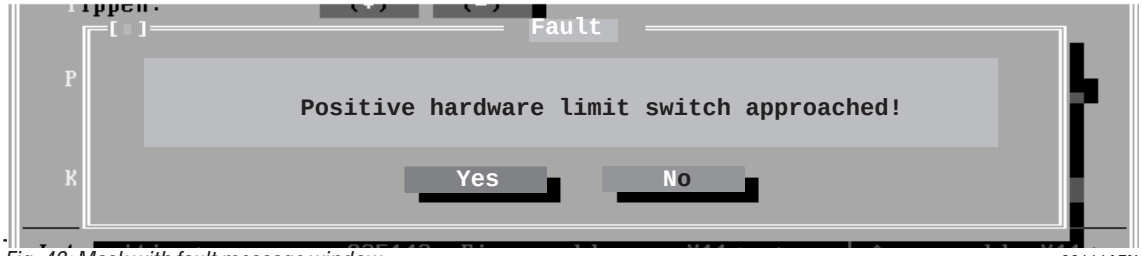


Fig. 43: Mask with fault message window 00111AEN

5.5.2 List of fault messages

The following list provides an overview of all fault messages which can occur during operation of the single- axis positioning control. In addition to pointing out possible causes it also tells you how to eliminate the fault.

Faults other than those associated with the positioning control (i.e. power supply and axis modules) are not listed here (for these see the MOVIDYN® Servo Controller Operating Instructions).

No.	Meaning	Possible Cause	Elimination
27	Emergency stop triggered	Both hardware limit switches open	Check connection of hardware limit switches.
29	Hardware limit switches swapped	Incorrect wiring?	Check wiring
40	Fault during boot synchronization	Defective positioning module	Contact Service
41	Watchdog tripped	Servo module faulty	Contact Service
42	Lag error	– Polarity encoder (K25) set incorrectly – Mechanical system (gear unit, hydraulics, friction) sluggish? – Axis hit obstacle? – Incorrect wiring of encoder or servo? – Acceleration too high? – P component of positioning controller (K 40) too small? – Speed control parameters incorrect? – Lag error tolerance (K23) too small? – Programmed speed greater than motor rated speed	

Table: Fault messages, part 1

No.	Meaning	Possible Cause	Elimination
43	Timeout during data transfer	Interruption of line to PC	Check leads and plugs
50	Positive hardware limit switch	travel exceeded switch: travel did not exceed switch: – Interruption of line to positive hardware limit switch	Travel in negative direction (e.g. jogging mode) Determine cause and eliminate
51	Negative hardware limit switch	travel exceeded switch: travel did not exceed switch: – Interruption of spaceline to negative hardware limit switch	Travel in positive direction (e.g. in jogging mode) Determine cause and eliminate
52	Positive software limit switch	Continuous travel while software limit switch monitoring activated – relative travel command Travel command to go to position outside travel range.	Switch off monitoring feature, setting both software limit switches to "0"
53	Negative software limit switch	Continuous travel while software limit switch monitoring is activated – relative travel command travel command to go to position outside the travel range	Switch off monitoring feature, setting both software limit switches to "0"
54	No home position defined (only reference travel type ≠ "0")	No reference travel (GO 0) or reference travel not accepted (SET 0)	Define home position and perform reference travel
55	Incorrect machine parameters	Incorrect value range	Check parameters(see section 3)
56	Addressed hardware not installed	Programming error	Correct program
57	Selected program does not exist	Programming error	Correct program
58	Jump to non-existing line number	Programming error	Correct program
59	Called program does not exist	Programming error	Correct program
60	Target position outside travel range	Incorrect value in speed instruction	Correct machine parameters (pos./neg. software limit switch) or program
61	Speed >Vmax	Incorrect value in speed range	Correct machine parameters (max. speed) or program
62	Flash EPROM fault	Error writing flash EPROM (flash EPROM defective)	Replace positioning module
63	Division by zero	Division by zero when calculating SET Hxx/Hyy	Correct program

Table: Fault messages, part 2

No.	Meaning	Possible Cause	Elimination
64	Maximum nesting depth reached	Programming error, e.g.endless loop (program is calling itself)?	Correct program
65	Position controller command error	Incorrect command to position controller	
66	Program memory full		Delete programs which are no longer required
67	Timeout in remote mode	Interruption of line to PC	Check leads and plugs
68	Target position not reached (time limit: 1 s)	– P component (K40) to small? – Positioning window (K24) too small? – Axis hit obstacle?	Check leads and plugs
69	No feed enable	No high level at terminal X11/6 “feed enable”	Check signal at terminal X11/6
70	Coded fault in the SSI section		
	Code 1: SSI interface error	Defective SSI module	Contact Service
	Code 2: SSI interface communication error	Defective SSI module	Contact Service
	Code 3: SSI encoder parity or powerfail error	Damaged encoder line, power supply interrupted, incorrect parameter setting	Check lines Check machine parameters
	Code 4: SSI module lag error	Faulty data transfer between encoder and APA 12	Ckeck lines and shielding
71	Coded error in the CAN section		
	Code 1: CAN timeout	CAN connection interrupted	Check connection
	Code 2: CAN receive buffer full	Systematic program error (CAN overload) excessive writing to an axis	Correct program
	Code 3: CAN controller overflow	CAN controller malfunction	Contact Service
	Code 4: CAN controller error	CAN bus malfunction No user response	Check wiring Check program
72	Index overflow (with indexed address)	Program error	Correct program
73	Illegal command for this axis status	SAVE command used during positioning operation Travel command activated while brake was still applied	Check program
74	Position outside calculation limit	Calculated position in increments $>2^{30}$	Check program

Table: Fault messages, part 3

F70 and F71 are coded faults; the individual code is displayed in the MD_POS status window.

5.5.3 Resetting a fault

Fault numbers 0 … 49

Faults with numbers 0 ... 49 cause the MOVIDYN® Servo Controller to be inhibited off immediately. The output stage is disabled and the brake output activated.

To reset these faults, follow the instructions below:

- Reset the fault via the MD_SHELL user interface in the [Parameter] menu (see MD_SHELL, section 4.2)

or

- Press button S1 on the front panel of the axis module

or

- Reset the fault via the "reset" terminal if one has been programmed

or

- Reset via the MD_POS user interface in the [Programming] menu, option [Axis module] (see section 2.4).

Fault numbers greater than 50

In general faults with a fault number greater than ≥ 50 are cleared when you reset the fault in the status display window or eliminate the fault.

Explicit clearance with the %RES command is not necessary.

Exception:
F70 and F71 can only be reset by deactivating and then reactivating the controller inhibit.

5.5.4 Responding to an EMERGENCY STOP

If the MOVIDYN® Servo Controller is supplied by an external 24V source, and a travel operation in the automatic mode is interrupted by an emergency stop, the travel can be resumed after power-up if the following conditions are met:

– Power-down must be prevented from causing a fault signal in the MOVIDYN® or in the APA 12/ API 12 (e.g. lag error), since after a fault reset, the APA 12/API 12 will be re-initialized .

– The travel program of the APA 12/API 12 must be designed accordingly.

Disconnecting and connecting the line voltage in ongoing automatic mode

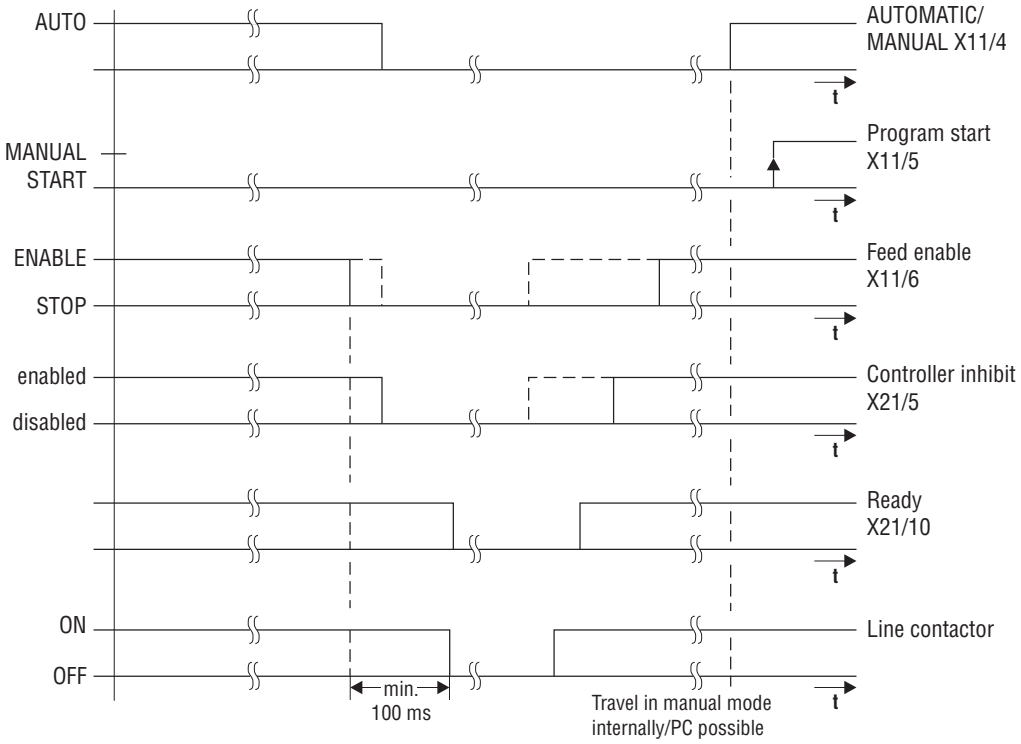


Fig. 44: Sequence diagram: Disconnecting and connecting the line voltage 00112AEN

Note

Program start is triggered by a positive edge of the “progr. start” signal at terminal X11/5.

Explaining the sequence diagram

- Before switching off the line contactor for the MOVIDYN®, the “feed enable” signal or the “controller inhibit” signal or both are to be removed. This prevents the generation of a fault signal. If the feed enable signal is removed, the system will decelerate along the internally set ramp. If the controller inhibit signal is removed, the output stage is switched off immediately and, if installed, the brake is applied.

- Whether the “automatic/manual” signal is removed depends on whether the axis, after renewed power-up, is to travel in manual mode or not.

- The “feed enable” and “controller inhibit” signals can be reapplied before the line contactor is switched on again.

- To start the automatic mode, the “Progr. start” signal must be applied again. The program start signal is only accepted after the “Ready for operation” signal becomes active.

Programming example for a travel program with resumption of program execution after power-up

```
%P01  (TEST PROGRAM)
N001  jmp (H00=0)N005   ; reset status
N002  jmp (H00=1)N020   ; interrupt when position 1 approached
N003  jmp (H00=2)N040   ; interrupt when position 2 approached
N004  jmp (M00=1)N020   ; perform reference travel only once
N005  GO 0              ; performing reference travel
N006  SET OV=1          ; override enable
N007  set M00=1         ; remember reference travel performed
N020  GO A800000 V2000  ; travel absolute to position 1
N030  set H00=1         ; remember position 1 being approached
N035  wait st           ; wait until position is reached
N036  WAIT 2000         ; waiting time 2s
N040  GO A0 V1500       ; travel absolute to position 2
N041  set H00=2         ; remember position 2 being approached
N042  wait st           ; wait until position is reached
N050  WAIT 2000         ; waiting time 2s
N060  JMP N020          ; repeat loop
```

Explanation

Program lines N001 - N003 represent a branch distributor. Depending on the state of variable H00, the program jumps to the respective travel command. The program remembers the traveling command executed in variable H00 (e.g. N020 - N035). If the supply is switched off, the automatic mode program is exited. After renewed program start (after the power-down and power-up sequences in accordance with the sequence diagram) the branch distributor branches to the last travel command and causes the axis to approach the respective target position.

Flag M00 remembers the execution of a reference travel to ensure it is only performed once.

Caution

In applications like the above only absolute travel commands may be used!

If the axis signals a fault with a fault number < 50, a subsequent reset of the axis will clear all flags and variables (< No. 50). A new reference travel must be performed. Program execution is terminated and will restart at the first program line.

If the supply is switched off, the values of variables and flags are retained if the system has an external 24V supply.

It is not necessary to modify the program if the target position is selected through table selection via external terminals, since the **absolute** target position is determined by the external control system (PLC, etc). It is necessary, however, to specify an **absolute target**, i.e. a command to go to an absolute position.

5.5.5 Emergency stop with continuation of program at stopped program line

If, after an emergency stop, the program is to be continued at the program line where it stopped, use the following sequence (Prerequisite: 24 V support mode):

Terminal / Function	Sequence / Status				
	1.	2.	3.	4.	5.
Auto / Manual	1	1	1	1	1
Start	1	1	1	1	1
Feed enable	1	0	0	0	0/1
Read enable	1	0	0	0	0/1
/ Controller inhibit	1	1	0	1	1
/ Brake	1	1	0	1	1
Position control	On	On	Off	On	On
Drive at rest	No	Yes	Yes	Yes	No
Comment	Drive is running	Emergency stop Drive stops	Power down	Power up	Execution of program continues

Table: Emergency stop sequencing mode with program continuation

Re 5: The program and any present travel command are continued.

If the Auto/Manual terminal goes low, the program will be restarted from the beginning on power-up after an emergency stop event.

Continuing the program by applying a feed enable and a read enable signal is only permitted after the MOVIDYN® has signaled that it is ready for operation.

6 MD_POS User Interface

6.1 General notes on how to operate MD_POS

The MD_POS user interface operates via a windowing technique in accordance with the SAA standard.

To operate the APA 12/API 12 single-axis positioning control you should already be familiar with the MOVIDYN® Servo Controller and the MD_SHELL user interface and know how to operate them (also see MD_SHELL user manual).

6.1.1 Operating the user interface

You can operate the MD_POS user interface either :

– with a mouse

– or from your PC keyboard

Using a mouse

- Move the mouse pointer to the field, menu line, etc..., of your choice and click the left mouse button.
  The marked function/selection is executed or called.

Using the PC keyboard

It is assumed that you are familiar with the use of a standard keyboard.
Below you will find a summary of the major functions:

Function	Key
Move cursor	Four arrow keys [←], [↑], [↓], [→]
Go to next field	TAB key [TAB I→]
Confirm entry or selection	<Return> key [↵]
Page down	PgDn key [Page down ↓]
Page up	PgUp key [Page up ↑]
Invoke specific function	Function keys [F1] to [F10] as shown in the function key line of the particular menu
Delete entry	DEL [del] key or Backspace [←]
Close window	Select the Exit field using the TAB key and press <Return> to confirm or press the [ESC] key (e.g. Help window) or simultaneously press the [ALT] key and the [F3] function key Also [Alt] + [A] (Abort) & [Alt] + [E] (End) for some menus
Highlight selection fields	Space bar

Table: Keyboard commands

6.1.2 Explaining the selection fields in the menus

Communication with the program is a accomplished through the menus via a limited number of selection fields.

Meaning of the selection fields

DISK

[Disk] addresses the hard disk of your PC.

Select [Disk] if you want to retrieve data from the hard disk of your PC to the main memory or save data to the hard disk.

When you select this field you will be prompted to enter a file name (file)

AXIS

[Axis] addresses the main memory of the respective axis module (axis).

Select [Axis] if you want to retrieve data from the APA 12/API 12 to the main memory of your PC or save data to the axis (the APA 12/API 12's memory).

When you select this field you will be prompted to enter the axis number.

Machine parameters are only effective and travel programs can only be used if they have been saved to the axis.

NEW

Selecting the [New] field allows you to create a new data record (e.g. machine parameters or travel programs).

When exiting the respective menu option remember to assign a name to your new file.

OK

Select the [OK] button to acknowledge fault messages displayed by the system or to confirm the program's default action (e.g. when saving data to the axis).

Select [OK] to close the message window.

OPEN

Select [Open] to read a data record from the hard disk to the main memory of your PC.

To read a data record, select the file name from the program's file selection list.

PRINT

Select [Print] to print out the respective data.

This feature is not available in all menu options.

To print data, make sure your printer is properly connected to your PC and ready for operation (on-line).

You cannot print to a file.

ESCAPE

Select [Escape] to exit a menu item without changing any data.

If you exit a menu item with [Escape] the file will remain just as it was when the menu item was called. Since no data were changed, the program will not ask you whether you want to save the file.

EXIT

Select [Exit] to exit the respective menu (e.g. the machine parameter menu).

When you select [Exit] you will always be asked whether you want to save the data.

SAVE

Select [Save] to save data to the hard disk of your PC.

Select this field if you have entered a valid file name or if you accept the file name suggested by the program and wish to save the data to the hard disk of your PC.

YES or **NO**

When exiting the MD_POS user interface the program will prompt you to confirm with either [Yes] or [No].

6.1.3 Selection windows

This section discusses the different windows which appear on the screen in connection with the PC's data management.

'Load data' window

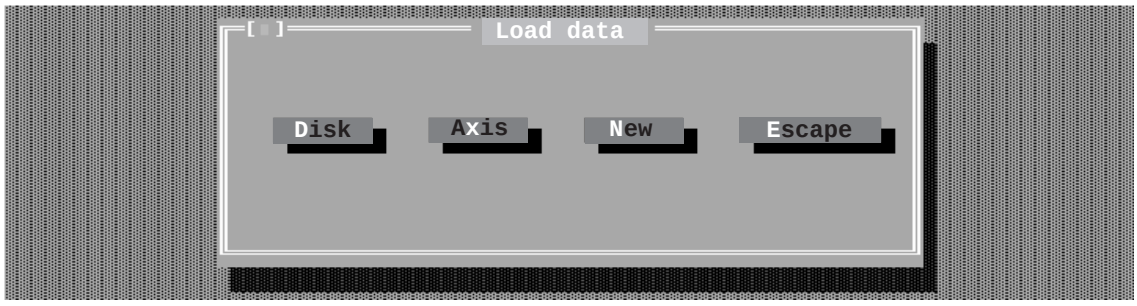


Fig. 45: "Load data' window 00113AEN

This window appears when you select a menu item which allows you to retrieve data records (e.g. machine parameters or programs).

You can select between [Disk], [Axis] or [New] (see section 6.1.2).

Selecting [Escape] will take you out of the window.

'Open file' window

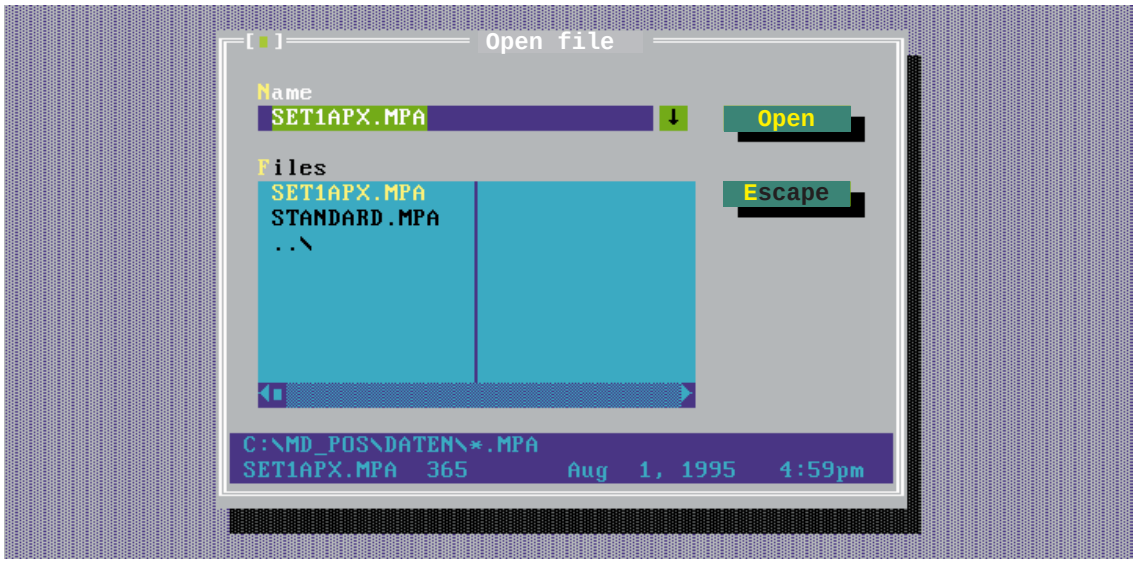


Fig. 46: 'Open file' window 00114AEN

The above window appears when you select [Disk] in the [Load data] window.

Enter the file name under which the data record is stored on the hard disk of the PC.

To load the desired file from the hard disk select [Open]. Selecting [Escape] will cancel this action.

'Axis selection' window

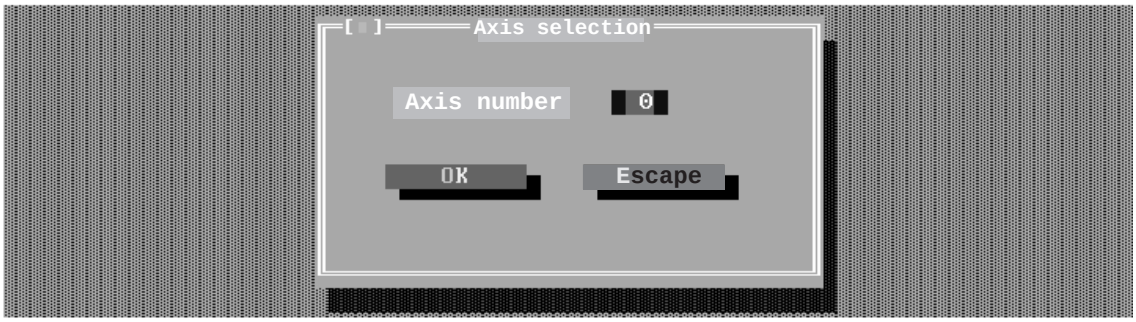


Fig. 47: 'Axis selection' window 00115AEN

Enter the [Axis number] in this window.

This window appears if you want to load data from the [Axis] to the PC or save data to the [Axis].

Select [OK] to load or save your data from or to the axis. [Escape] will abort this action.

'Save data' window

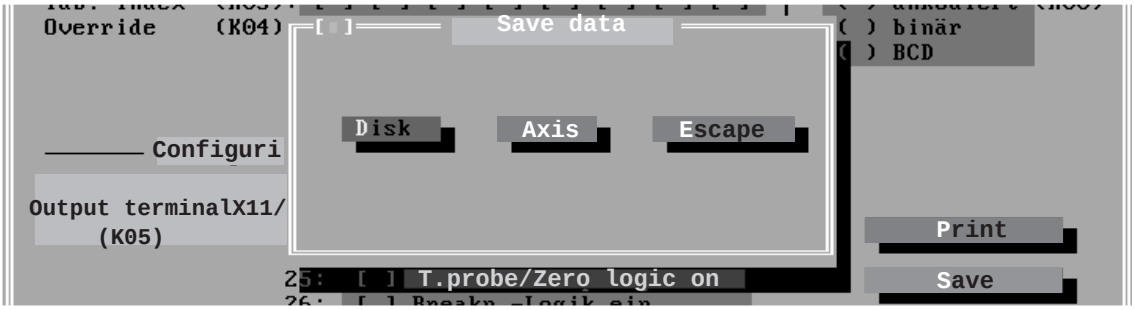


Fig. 48: 'Save data' window 00116AEN

This window appears when you select [Exit] to exit a menu option and need to save previously entered data (e.g. machine parameters or programs).

You can save your data either to [Disk] or [Axis] (see section 6.1.2).

Selecting [Escape] will abort the action without taking you out of the menu option.

'Save file' window

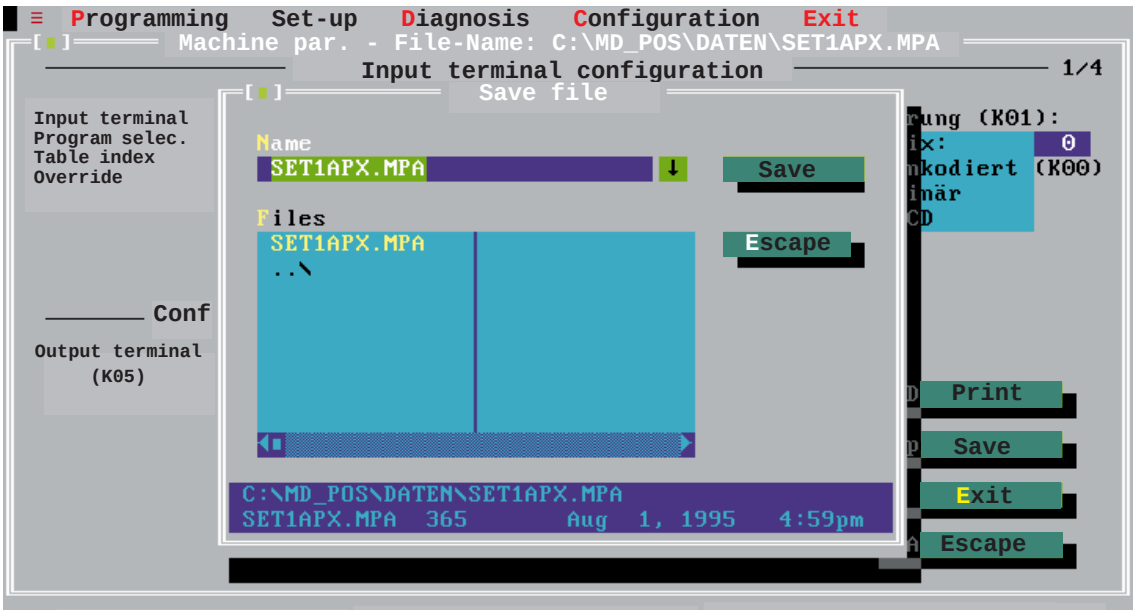


Fig. 49: 'Save file' window 00117AEN

This window appears on selecting [Disk] in the [Save data] window.

Enter a file name under which to save the previously entered data to the hard disk of the PC.

Select [Save] to save the file to the hard disk or [Escape] to cancel the action without exiting the menu option.

6.2 Main menu

After calling MD_POS the program's main menu will appear and the following window will open:

This window displays the current software version status of MD_POS.

- Click [OK] to confirm.
  The window will close.

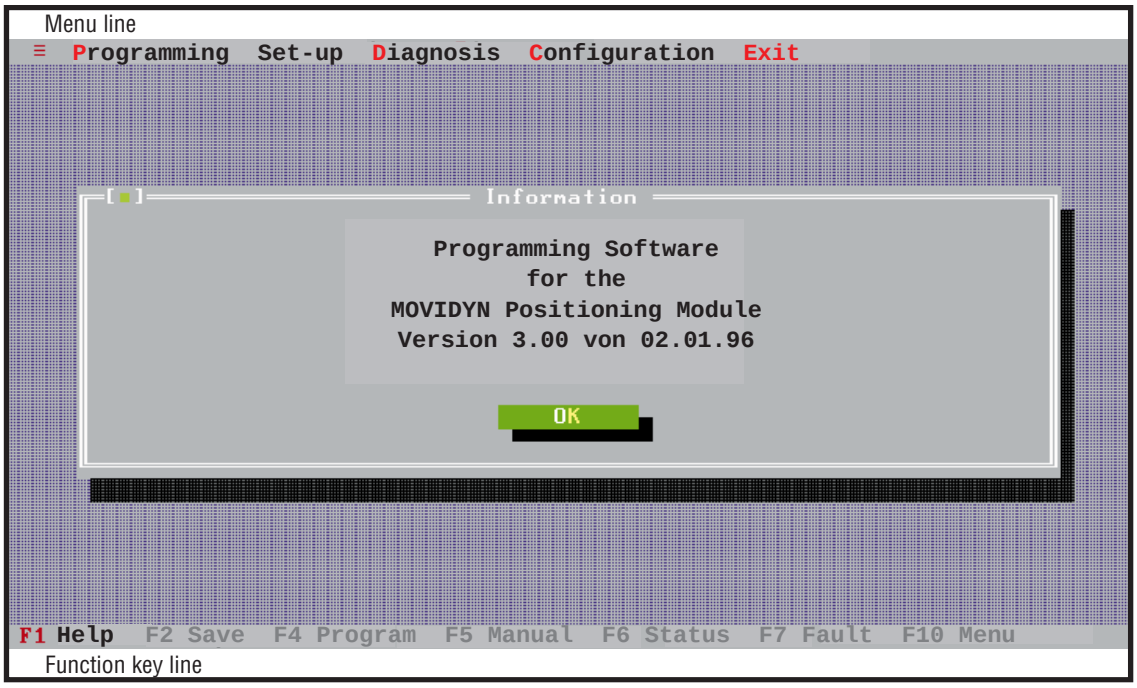


Fig. 50: Main menu 00118AEN

The menu line contains the individual menus available for selection:

- Programming
- Set-up
- Diagnosis
- Configuration
- Exit

The function key line shows the assignment of the function keys:

–	F1	Help	Displays the on-line Help (not available from all menus)
–	F2	Save	Displays the [Save] menu
–	F4	Program	Displays the [Program] submenu of the [Programming] menu
–	F5	Manual	Displays the [Manual mode] submenu of the [Set-up] menu
–	F6	Status	Displays the [Status] submenu of the [Diagnosis] menu
–	F7	Fault	Displays the [Fault report] submenu of the [Diagnosis] menu
–	F10	Menu	Activates the menu line

6.3 MD_POS menu structure

Overview of the menu system

The diagram below shows the structure of the menu system.

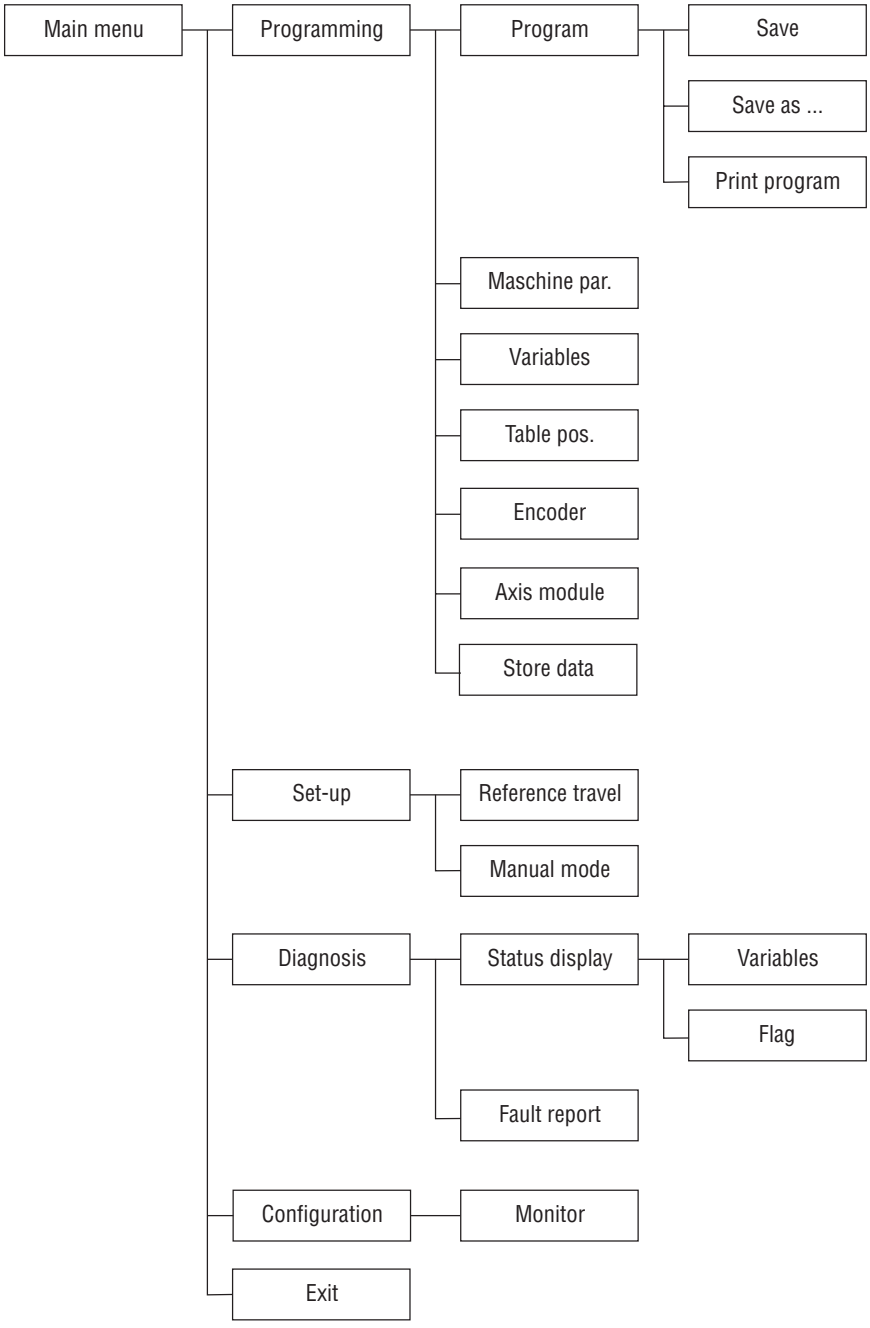


Fig. 51: Menu structure 00119AEN

6.3.1 Programming menu

The [Programming] menu contains the following menu options

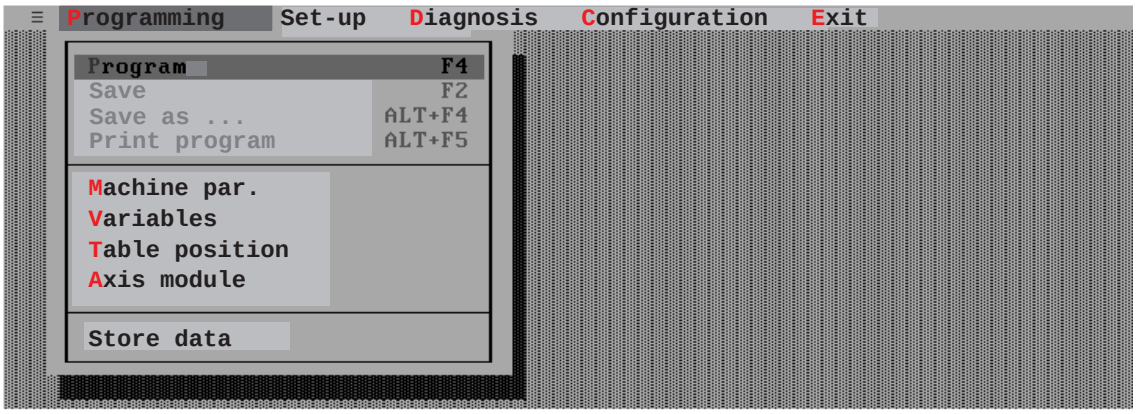


Fig. 52: Programming menu 00120AEN

[Program]

Select this menu to write or edit travel programs.

Activating the [Program] menu will activate the program editor, where you may enter programs. For a description of the command set used to write these programs see section 7.

[Save], [Save as...] and [Print program] are only active while in the [Program] editor and serve to save and print the program.

[Machine par.]

Select this menu item to define or edit machine parameters for an axis.

The [Machine par.] menu comprises four pages where the parameters for the axis are entered.

For a description of the menu and entry of machine parameters see section 2.

If editing machine parameters of an existing axis: see section 4.3

[Variables]

The [Variables] menu, consisting of five submenus, allows you to view, enter and edit the variables used in travel programs. The variables (00 to 99) are either defined and entered by the programmer of the travel programs or set by the program itself and entered in the APA 12/API 12 variables memory.

Description and use of the [Variables] menu: see section 7.4

[Table pos.]

The [Table pos.] menu allows you to enter up to 16 positions when programming travel programs. The axis will travel to the position entered here when the table position (00 to 15) selected via the input terminals is invoked in the program.

Description and use of the [Table pos.] menu: see section 7.5

[Encoder]

The [Encoder] menu allows you to delete encoder entries, edit them or add new encoders to the list.

Description of the [Encoder] menu: see section 2.4

[Axis module]

The [Axis module] menu allows you to edit the speed controller parameters of the basic MOVIDYN® Servo Controller without having to go to the MD_SHELL user interface.

Speed controller parameters are set in accordance with the MOVIDYN® Servo Controller Operating Instructions, section 3.3.

To ensure an optimum control response, the parameters of the position controller of the APA 12/API 12 must correlate with those of the speed controller of the MOVIDYN® Servo Controller.

For a description of the [Axis module] menu: see section 2.4

[Store data]

The [Store data] menu allows you to store all data of an axis (machine parameters, variables, table positions and travel programs) in the flash EPROM of the APA 12/API 12 positioning control.

Saving data: see section 4.5

6.3.2 Set-up menu

The [Set-up] menu contains the following menu options:

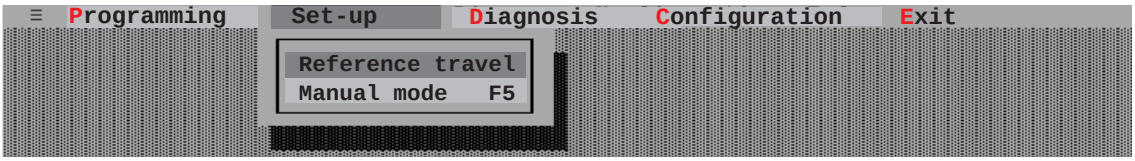


Fig. 53: Set-up menu 00121AEN

[Reference travel]

Select this menu to have the axis perform a reference travel to the home position.

The screen that appears shows the actual position and the target position of the axis, the status of the input and output terminals, status of the limit switches as well as some other status information.

For a description of the [Reference travel] menu and performance of a reference travel: see section 4.2.2

[Manual mode]

The [Manual mode] menu lets you move the axis in the on-line mode via the serial interface (without a positioning program). When the menu is activated, MD_POS communicates continuously with the axis module. A command line allows you to send commands to the axis (see section 7.2).

Input fields allow you to define parameters for manual mode travel. In addition, this menu also provides information on the status of the axis.

For a description of the [Manual mode] menu and manual travel: see section 4.2.4.

6.3.3 Diagnosis

The [Diagnosis] menu contains the following submenus:

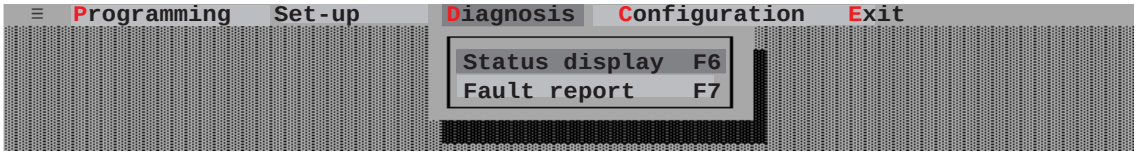


Fig. 54: Diagnosis menu 00122AEN

[Status display]

The [Status display] menu provides information about the status of the APA 12/ API 12.

[Fault report]

The [Fault report] menu provides a list of all faults occurred in the order of their occurrence.

For a description of the [Diagnosis] menu: see section 5.1

6.3.4 Configuration menu

The [Configuration] menu contains the following menu item:

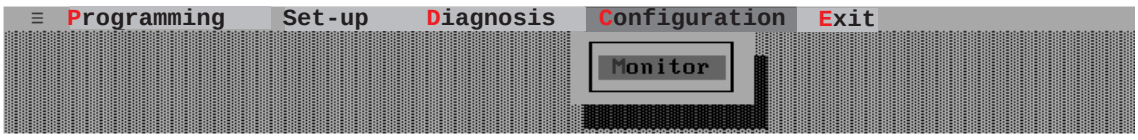


Fig. 55: Configuration menu 00123AEN

[Monitor]

The [Monitor] menu option offers the following monitor types for selection:

- Color monitor
- Monochrome LCD
- Monochrome monitor

6.4 Exiting the program

The [Exit] menu takes you out of the MD_POS user interface and back to the MD_SHELL program (see section 4.6).

On selecting the [Exit] menu the program will prompt you:

Fig. 56: Exit menu 00124AEN

Exiting the program

Select [Yes] to exit the MD_POS program.
This will take you back to the MD_SHELL user interface.

Escape

If you do not want to exit the program, click the [No] button and remain in MD_POS.

6.5 Help feature

In some menus you can open a Help window by pressing the F1 function key.

This Help window contains information about the functions and actions associated with the menu option you are in.

- Press the F1 function key to open the Help window.
- Use the cursor keys (up and down arrow keys) and the PgUp and PgDn keys to move inside the the window.
- To close the Help window either
  - move the mouse pointer to the small green square in the upper left of the window and click on it
  - or press the [Esc] key
  - or press the [Alt]+ [F3] keys.

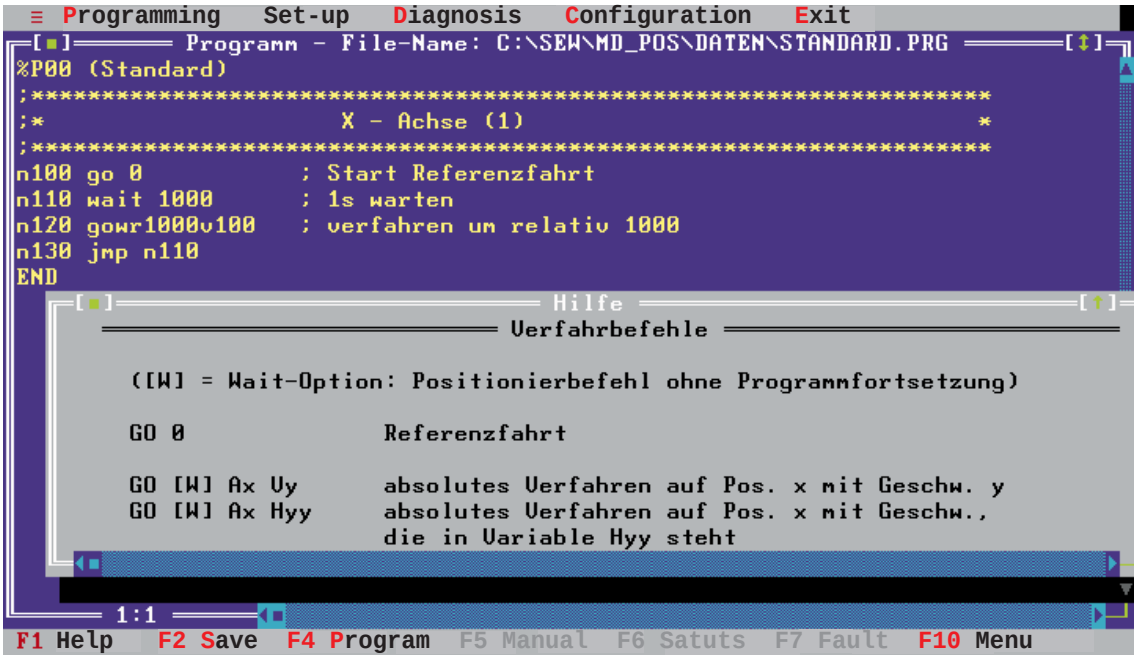

≡ Programming Set-up Diagnosis Configuration Exit
Programm - File-Name: C:\SEW\MD_POS\DATEN\STANDARD.PRG
%P00 (Standard)
;***
;* X - Achse (1) *
;***
n100 go 0 ; Start Referenzfahrt
n110 wait 1000 ; 1s warten
n120 gowr1000v100 ; verfahren um relativ 1000
n130 jmp n110
END
Hilfe
Verfahrbefehle
([W] = Wait-Option: Positionierbefehl ohne Programmfortsetzung)
GO 0 Referenzfahrt
GO [W] Ax Vy absolutes Verfahren auf Pos. x mit Geschw. y
GO [W] Ax Hyy absolutes Verfahren auf Pos. x mit Geschw.,
die in Variable Hyy steht
1:1
F1 Help F2 Save F4 Program F5 Manual F6 Satuts F7 Fault F10 Menu

Fig. 57: Example of a Help window in the program editor 00125AEN

Notes on how to manipulate the Help windows

Using a mouse allows you to position the window anywhere on the screen and size it as you like.

To position the window on the screen, click and hold the upper bar in the Help window and drag the window to its new position by moving the mouse.

To resize a window click and hold the lower right corner of the Help window and drag the mouse until your window is the desired size.

7 Travel Programs

The MD_POS interface offers two options for controlling the individual axes:

- programming and executing travel programs (see section 7.1)
- entering commands in the [Manual mode] menu (see section 7.2).

7.1 Programming travel programs

Travel programs are written in the program editor. Individual commands to control the axis are compiled into a complete program. Each program must be assigned a program number and can be saved either to the computer hard disk or directly to the axis (flash EPROM).

Programs are called and started via input terminals X11/4 and X11/5 or from another program (see section 4.2.5).

In section 7.1.4 you will find several examples discussing the structure of these travel programs and their commands. Section 7.3.1 contains an overview of all commands in a quick reference table.

7.1.1 Program editor

Starting the program editor

- Go to the [Programming] menu and select [Program]

or

- Press F4
  to display the [Load data] selection window.
- You may
  - load a program from a [Disk]
  - load a program from an [Axis] or
  - write a [New] program.

  The program editor is opened. You may now edit the selected program or write a new program.

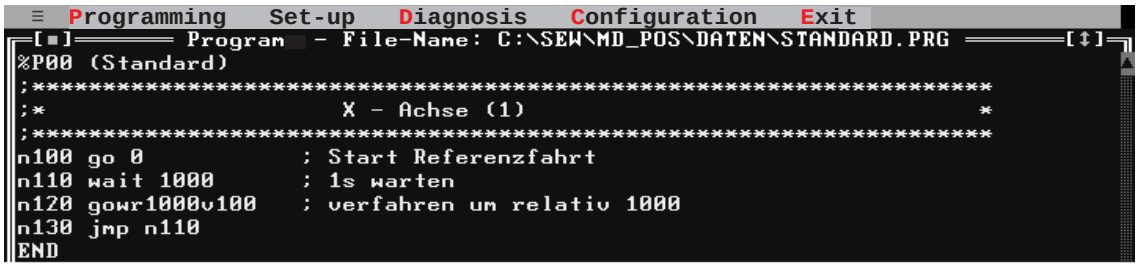


Fig. 58. Program editor (example) 00126AEN

Editor commands

The MD_POS program editor commands are compatible with the Turbo-C editor by Borland. All major editor commands are listed below.

Cursor movement keystrokes		
<Crtl> + <S>	<→> (cursor key)	Left one character
<Crtl> + <D>	<←> (cursor key)	Right one character
<Crtl> + <A>		Left one word
<Crtl> + <F>		Right one word
<Crtl> + <E>	<↑> (cursor key)	Up one line
<Crtl> + <X>	<↓> (cursor key)	Down one line
<Crtl> + <R>	<Page up>	Up one page
<Crtl> + <C>	<Page down>	Down one page
Extended cursor movements		
<Crtl> + <Q> + <S>	<Pos1>	To beginning of line
<Crtl> + <Q> + <D>	<End>	To end of line
<Crtl> + <Q> + <R>	<Crtl> + <PgUp>	To beginning of document
<Crtl> + <Q> + <C>	<Crtl> + <PgDn>	To end of document
Insert		
<Crtl> + <V>	<Ins>	Insert mode on/off
<Crtl> + <V>		Insert line above current cursor position
<Crtl> + <I>	<TAB>	Insert Tab
Delete		
<Ctrl> + <H>	<←>	Delete character left of cursor
<Ctrl> + <G>	<Del>	Delete character below cursor
<Ctrl> + <T>		Delete word at cursor position
<Ctrl> + <Y>		Delete line
<Ctrl> + <Q> + <Y>		Delete to end of line
Block operations		
<Ctrl> + <K> + <B>		Highlight beginning of block
<Ctrl> + <K> + <K>		Highlight end of block
<Ctrl> + <K> + <C>		Copy block
<Ctrl> + <K> + <Y>		Delete block
Search/Replace		
<Ctrl> + <Q> + <F>		Search
<Ctrl> + <Q> + <A>		Search and replace
<Ctrl> + <L>		Repeat search and replace
Exit/Save		
<Alt> + F3		Exit editor and save or exit without saving

Table: editor commands

7.1.2 Program structure

Each program is comprised of:

- program header
- command lines
- *End* statement

Program header

```
% Pxx (a)
```

xx = program number (two-digit, 00...99)
a = program name (max. 20 characters); entry of a program name is not mandatory, but the parentheses enclosing the program name are required.

Commands

```
Nxxx      <Command>
```

xxx = Line number of the command set (max. 1000). Use incrementing line numbers when numbering the command lines. Line numbers can be used in non-sequential increments to allow insertion of additional command lines to modify the program later.

End statement

```
END
```

Each program must end with an END statement.

Comments

```
;    Comment
```

Comments can be added to the end of a program line. Comments are used to help make the program readable by describing the function of a line or section of program code. Comments are preceded by a semi-colon (;) and may not exceed one line in length.

Example:

```
%P01  (Test program)
;————————————————————————
; use ; to insert a comment
;————————————————————————

N100  GO   0              ; start reference travel
n200  GOWA   1000V100     ; absolute positioning
```

Note:

Comments are only stored if the program is saved to diskette/hard disk, not if it is saved to the axis. The print option will always print the characters displayed on the screen.

7.1.3 Commands in travel programs

All available commands are discussed in section 7.3.
There are:

- jump instructions
- program calls
- set commands
- positioning and travel commands
- wait instructions and
- status commands.

7.2 Commands for manual mode

7.2.1 Entering commands

- In the [Set-up] menu select the [Manual mode] option or press F5. The manual mode menu will be displayed on your screen.

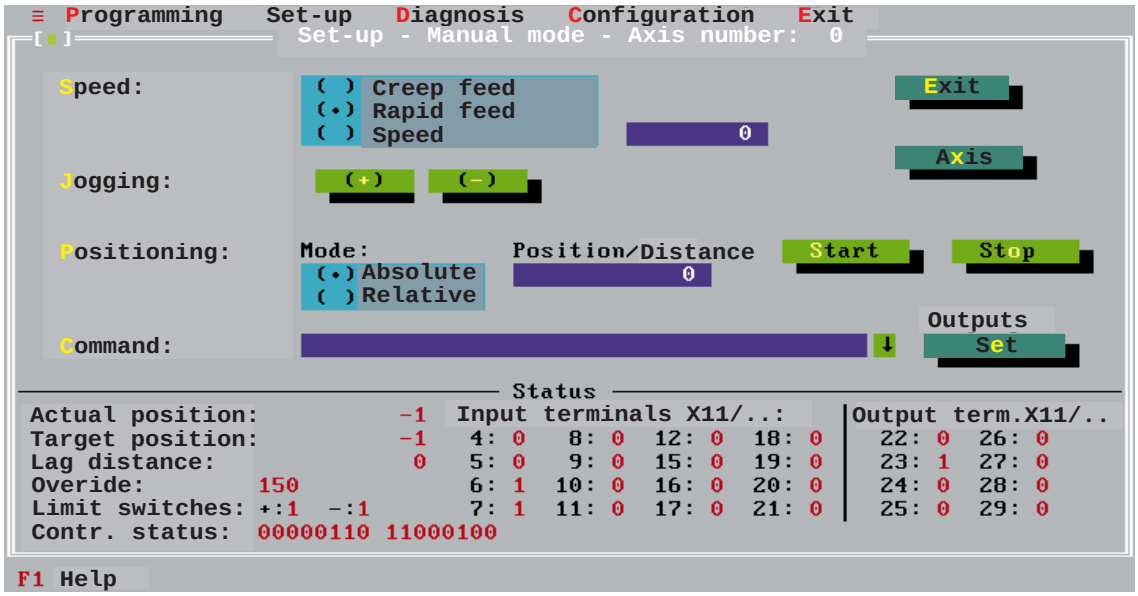


Fig. 59: Manual mode menu 00127AEN

- Enter the required command in the [Command line].
- Press <Return> to confirm your entry.

7.2.2 Data management

The data management commands allow you to manage programs, records, machine parameters, variables, table positions and flags.

7.2.2.1 Overview of data management commands

The following section contains an overview of all data management commands. These commands are only effective in the Manual mode. They are transferred automatically from the [Manual mode] window to the selected axis without the need for explicit save command.

Program memory data

- The program memory of the positioning module can a maximum of 100 programs (P00...P99).
- When using the Store option, the programs are stored in non-volatile memory (flash EPROM).
- A program can contain a maximum of 1000 program lines (N000...N999).
- The number of programmable lines is limited to a maximum of 3000 (e.g. 3 programs with a maximum number of 1000 lines each).

7.2.2.2 Transferring/Requesting programs

Transferring a program

%Pxx (a)	program header:	xx = program number (two- digit, 00...99) a = program name (max. 20 characters)
Ny ... **"** **"**	program line:	y = program line number (0 ... 999) ... = command
END		End statement

Note: To overwrite an existing program, first delete it.

Requesting a program

%RD Pxx	(RD = Read)	xx = program number (two- digit, 00...99)
Acknowledgement:	if program exists	see "Transferring a program"
	if program does not exist	error message

Transferring a program line

%Pxx Ny ...	xx = program number (two- digit, 00...99) y = program line number (0 ... 999)

If the program to be transferred does not exist, an error message is generated.
If the program and line number being transferred already exist, the existing program line is overwritten, otherwise the "new" program line is inserted in the program.

Requesting a program line

%RD Pxx Ny	xx = program number (two- digit, 00...99) y = program line number (0 ... 999)

Acknowledgement: if program and program line number exist %Pxx Ny ...
if program and line number do not exist error message

7.2.2.3 Deleting a program line

Deleting a program

%CL Pxx (CL = Clear) xx = program number (two-digit, 00...99)

Delete all programs

%CL PXX (CL = Clear)

Deleting a program line

%CL Pxx Ny xx = program number (two- digit, 00...99)
y = program line number (0 ... 999)

Acknowledgement: if program and line number exist line deleted
if program and line number do not exist error message

7.2.2.4 Requesting directory

%DIR (DIR = Directory)

Acknowledgement:
- program numbers, names and number of programmed lines (if applicable)
- total number of programmed lines
- software version of positioning module and
- number of program lines still available

Examples:
```
P01 (example 1) N20
P05 (example 5) N35
V100 USED: 55 FREE: 2945
```

7.2.2.5 Storing data in the flash EPROM

This command will save the user data (machine parameters, table positions, programs and variable values H00...H99) from the main memory to the non-volatile memory (flash EPROM). This will take several seconds.

%SAVE

You should only use the SAVE command when writing your own programs for modifying variables or setting the APA 12/API 12 parameters via a serial interface, e.g. a PLC. When you enter the command via the command line of the manual mode menu MD_POS generates a timeout message, because storing the data will take several seconds and the command line entry mode does not provide for this.

7.2.2.6 Transferring and requesting machine parameters

These parameters contain data affecting machine operation and generally do not require editing (for more detailed information see section 3). They are stored in non-volatile memory and are loaded by the axis upon power-up.

Transferring and modifying of machine parameters

%Kxx : a

xx = machine parameter index
a = machine parameter value

Requesting all machine parameters

%RD KXX (RD = Read)

Acknowledgement: see “Transferring machine parameters”

Requesting a machine parameter

%RD Kxx (RD = Read)

xx = index of the desired machine parameter

Acknowledgement: **Kxx : a**

xx = machine parameter index
a = machine parameter value

7.2.2.7 Transferring and requesting variables (H00…H99)

The variable memory can store position, speed, counter and timer values, for use in the program.

Transferring or editing variables

%Hxx : a

xx = variable index
a = variable value

Requesting the variable memory

%RD HXX (RD = Read)

Acknowledgement: see “Transferring variables”

Requesting a variable

%RD Hxx (RD = Read)

xx = index of the desired variable

Acknowledgement: **Hxx : a**

xx = variable index
a = variable value

7.2.2.8 Transferring and requesting counters (C00…C99)

Transferring and editing counters

%Cxx : a

xx = counter index
a = counter value

Requesting all counters

%RD CXX (RD Read)

Acknowledgement: see “Transferring variables”

Requesting a counter

%RD CXX	(RD = Read)	xx = index of desired counter
Acknowledgement: **Cxx:a**		xx = counter index a = counter value

7.2.2.9 Transferring and requesting table positions (T00…T15)

The position table stores position values, to which the axis can be positioned in the user program via input terminal selection and the GOT ... commands.

You can transfer the table positions as a whole, in part or individually.

After power-up, the table positions are set to the values stored in the flash EPROM.

Transferring table positions

%Txx:a	xx = table position index a = table position value

Requesting table positions

%RD TXX (RD = Read)

Acknowledgement: see “Transferring table positions”

Requesting a table position

%RD Txx	(RD = Read)	xx = index of desired table position
Acknowledgement: **Txx:a**		xx = table position index a = value of table position

7.2.2.10 Requesting flags (M00 … M99)

Flags are variables, which can only have two possible states: 0 or 1. In the program they are set with SET M ... commands and read with JMP (M ...) commands.

Requesting all flags

%RD MXX (RD = Read)

Acknowledgement:
M00:a
M01:b
M02:c
“
”
M99:d

a, b, c, d = flag value (0 or 1)

Requesting a flag

%RD Mxx	(RD = Read)	xx = index of the requested flag
Acknowledgement: **%Mxx:a**		xx = flag index a = flag value (0 or 1)

Setting a flag

%Mxx:a	xx = flag index a = flag value (0 or 1)

7.2.2.11 Requesting encoder position (only with SSI module)

%RD SSI (RD = Read)

Between K55 and the max. position the following applies:

$Pos_{SSI} = Pos_{encoder}$

from the max. position:

$Pos_{SSI} = Pos_{encoder}$ + K55 (encoder reference position)

This command is used for service purposes and is only useful when the axis is at rest.

7.2.2.12 Switching manual mode on and off

%+R [s]	Switches manual mode on and defines the interface timeout period.
%-R	Switches manual mode off.

Example	**%+R [s]**	s = 0: timeout switched off s = 1 ... 65535 [variable length] s ≠ 0: timeout period in ms
	%R	no entry for s: default 500 ms

7.2.3 Commands in manual mode

All available commands are discussed in section 7.3.
There are:

- Set commands
- Positioning and travel commands
- Status commands

Note

Jump instructions and program call instructions cannot be used when in manual mode (remote mode).

7.3 Commands

Below you will find a listing of all travel program commands.
For a detailed description see section 7.3.2.
Program examples: section 7.9

7.3.1 Overview

The following overview shows the entire APA 12/API 12 command set. Values separated by a "/" indicate alternate qualifiers for that particular command type.

Jump instructions / Program calls	
DESTINATION:	NY = line number to jump to END = jump to program end Pyy = number of subroutine to be called P[Cyy] = number of subroutine to be called in Cyy
JMP DESTINATION	Jump to DESTINATION
JMP (Ixxx = 0 / 1) DESTINATION	if digital input = 0 / 1 to DESTINATION
JMP (Iqqi = 0 / 1) DESTINATION	if digital input port qq with input number 1 = 0 / 1 to DESTINATION
JMP (Oxxx = 0 / 1) DESTINATION	if digital output = 0 / 1 to DESTINATION
JMP (IP> / < x) DESTINATION	if actual position greater / less than value to DESTINATION
JMP (IP> /< Hxx) DESTINATION	if actual position greater / less than variable to DESTINATION
JMP (SP> / = / < x) DESTINATION	if target position greater / equal to / less than (direct) to DESTINATION
JMP (SP> / = / < Hxx) DESTINATION	if target position greater / equal to / less than (via variable) to DESTINATION
JMP (PW = 0 / 1) DESTINATION	if target position reached and actual position (not /) in position window to DESTINATION
JMP (Mxx = 0 / 1) DESTINATION	if flag = 0 / 1 to DESTINATION
JMP (M[Cxx] = 0 / 1) DESTINATION	if indexed flag = 0 / 1 to DESTINATION
JMP (Cxx > / = / < d) DESTINATION	if greater / equal to / less than counter value to DESTINATION
JMP (Hxx > / = / < z) DESTINATION	if variable greater / equal to / less than to DESTINATION
JMP (H[Cxx] > / = / < z) DESTINATION	if indexed variable greater / equal to / less than to DESTINATION
MP (Hxx > / = / < Hzz) DESTINATION	if variable xx greater / equal to / less than variable zz, to DESTINATION
JMP (H[xx] > / = / < H[zz]) DESTINATION	if indexed variable xx greater / equal to / less than indexed variable zz, to DESTNATION
JMP (Zxx > / < d / = 0) DESTINATION	if timer greater / equal to / less than 0 to DESTINATION
JMP (BK = 0 / 1) DESTINATION	if breakpoint (not /) reached to DESTINATION
JMP (TP = 0 / 1) DESTINATION	if touch probe (not /) reached to DESTINATION
JMP (ST = 0 / 1) DESTINATION	if axis (not /) stopped to DESTINATION

Table: Overview of travel program commands, part 1

Set commands	
SET: a: ...	An optional axis identifier: a: may be entered after the command word SET in all SET commands: a: 0 ... 7: axis number @: broadcast message (to all axes including the own)
SET Oxxx = 0 / 1	set digital output = 0 / 1 (individual)
SET Ozz = Pyy	set output port to the hex value yy
SET Oppo = (Iqqi / Mxx / Orrk & / I I2ok / Myy / Oqqi)	set local output port to result from AND/OR of input / flag / output and input / flag / output
SET Oppo = Mxx	set output port to flag
SET Oppo = Cyy	set mask for port pp with counter Cyy
SET Mxx = 0 / 1 / Myy / - Myy	set flag = 0 / 1 flag yy / flag yy negeted
SET Mxx = (Iqqi / Myy / Orkk & / I Irrk / Mzz / Oqqi)	set flag to result from AND / OR of input / flag output and input / flag / output
SET M[Cxx] = (Iqqi / Myy / Orrk & / I Irrk/ Mzz / Oqqi)	set indexed flag to result from AND / OR of input / flag output and input / flag / output
SET Hxx = y / Hyy / H[Cyy] / Cyy / Tyy	set variable = y / variable yy / indexed variable yy / counter / table position
SET H[Cxx] = y / Hyy / H[Cyy] / Cyy / Tyy	set indexed variable = y / variable yy / indexed variable yy / counter / table position
SET Hxx = IP / SP / OV / TP	set variable = actual position / target position / override / touch probe position
SET H[Cxx] = IP / SP / OV / TP	set indexed variable = actual position / target position / override / touch probe position
SET Hxx + / - / * / :y / Hyy	calculated variable by adding / subtracting / multiplying / dividing variable to / from / byy / variable
SET H[Cxx] + / - / * / :y / Hyy	calculated indexed variable by adding / subtracting / multiplying / dividing variable to / from / byy / variable
SET Cxx = d / Hyy / Cyy / Iqq / Opp	set counter direct / via variable / to counter yy / to input port / to output port
SET Cxx + / - y / Hyy	add / subtract y / variable to / from counter
SET Txx = d / Hyy / IP / SP	set table position direct / via variable / to actual position / to target position
SET T [Cxx] = d / Hyy / IP / SP	set indexed table position direct / via variable / to actual position / to target position
SET Zxx = d / Hyy	set timer direct / via variable
SET BA / BR = d / Hyy	set absolute / relative breakpoint direct / via variable
SET O / NP	accept current actual position / target position as reference position
SET TP / NL	activate touch probe logic / zero point logic (inquire with JMP (TP = ...))
SET SP / IP = d / Hyy	set target position / actual position direct / via variable
SET OV = 0 / 1	set override to 0 (off) / 1 (on)
SET K15 = 0 / 1	set accel. / decel. type to linear / $\sin^2$
SET K16 / K17 = d / Hyy	set max. accel. / decel. = d / Hyy
SET K26 / K27 = d / Hyy	set $\sin^2$ form factor accel. / decel. = d / Hyy
SET K40 = d / Hyy	set P component = d / Hyy
SET BRAKE = 0 / 1	release / apply mechanical brake

Table: Overview of travel program commands, part 2

Positioning and travel commands	
GO 0	carry out reference travel (K30)
	Go to certain pos. (absolute) / travel certain distance (relative)
GO Ax / Rx Vy / Hy	with continuation, pos. / distance directly, speed directly / via variable
GO A Hxx / R Hxx Vy / Hyy	with continuation, pos. / distance via variable, speed directly / via variable
GOW Ax / Rx Vy / Hyy	without continuation, pos. / distance directly, speed directly, via variable
GOW A Hxx / R Hxx Vy / Hyy	without continuation, pos. / distance via variable, speed directly / via variable
	Position to table position
GOT A / R Vy / Hyy	with continuation (absolute) / (relative), speed directly / via variable
GOTW A / R Vy / Hyy	without continuation (absolute) / (relative), speed directly / via variable
	Position to touch probe
GOTP Rx / R Hxx Vy / Hyy	with continuation, distance directly / via variable speed directly / via variable
GOTPW Rx / R Hxx Vy / Hyy	without continuation, distance directly / via variable speed directly / via variable
	Continuous travel / deceleration
GO V + y / -y / Hxx	positive / negative direction (directly) / via variable
STOP B / M / O	with programmed / max. decel., then position control / with max. decel., no position control
Wait commands	
WAIT x / Hxx / (Ixx = 0 / 1)	waiting time directly / via variable / until input xx = 0 / 1
WAIT BK / TP / ST / NL / PW	wait for breakpoint / touch probe / axis stop / encoder zero / target position reached and actual position in position window
WAIT (Iooo = 1 / 0)	wait until input Iooo = 1 / 0
Save command	
SAVE	
Status command	
? / ? (x)	status request / single status request with index x
Program and data management commands (only for commands in manual mode)	
% DIR	request directory
% RD Pxx / % RD Pxx Ny	request program number xx / program line number y from program number xx
% RD MXX / % RD Mxx	request all flags (M00...M99) / flag number xx
% RD TXX / % RD Txx	request all table positions (T00... T15) / table position number xx
% RD HXX / % RD Hxx	request all variables (H00...H99) / variable number xx
% RD CXX / % RD Cxx	request all counters (C00...C99) / counter number xx
% RD KXX / % RD Kxx	request all machine parameters / machine parameter number xx
% RD SSI	request encoder information (SSI only)
% Pxx Ny	insert / overwrite program line number y in program number xx
% Pxx (a)	transmit program number xx and name a
% CL PXX / % CL Pxx / % CL Pxx Ny	delete all programs / program number xx / program line number y from program number xx
% Txx:y / %Hxx:y / %Mxx:y / %Kxx:y	set table position / variable / flag / machine parameter to y
%SAV	save all user data from RAM to non-volatile memory (flash EPROM)
%+/-R[s]	switch on / switch off manual operation

Table: Travel program commands, part 3

Caution
Do not use the following commands:

%DEL	Delete complete non-volatile user data memory
%RES	Reset fault signal

7.3.2 Detailed discussion of the commands

7.3.2.1 Jump instructions / Program calls

These commands are only effective as part of a program.

Jump instructions

The jump destination is specified by the line number : **`JMP Ny`**

If the program is to jump to the program end, the END statement is entered instead of the line number Ny: **`JMP END`**

Program calls

Generally, any program may be called from another program. After the called program has been executed, execution of the original program is continued at the line following the program line that originated the call.

The nesting depth for program calls is 10. If this nesting depth is exceeded, a fault message is issued and execution of the running program is interrupted.

Unconditional jump / program call

`JMP Ny / END / Pyy`
y = line number (0...999):
yy = number of program to be called (00 ... 99)

Conditional jump / program call

The following jump functions / program calls are linked to a certain condition which is specified in parentheses.

If the condition is satisfied, the program will jump to the specified line number, the program end or the program call. If not, the program continues with the following line.

Conditions for jump instructions / program calls can be:

- **Status of a digital input**
  - Status = 0 / 1:
    `JMP (Ixxx = 0 / 1) Ny / END / Pyy`
    y = line number (0...999)
    yy = number of program to be called (00...99)

xxx =	000	001	002	003	004	005	006	007
Input terminal	X11/4	X11/5	X11/6	X11/7	X11/8	X11/9	X11/10	X11/11
xxx =	010	011	012	013	014	015	016	017
Input terminal	X11/12	X11/15	X11/16	X11/17	X11/18	X11/19	X11/20	X11/21

- **Status of a digital output**

  – Status = 0 / 1:
  JMP (Oxx = 0 / 1) Ny / END / Pyy
  y = line number (0...999)
  yy = number of the program to be called (00...99)

xxx =	000	001	002	003	004	005	006	007
Output terminal	X11/22	X11/23	X11/24	X11/25	X11/26	X11/27	X11/28	X11/29

Important
"xxx" values other than the ones above are reserved for future revisions!

- **Status of an input port**

  – Status = 0 / 1:
  JMP (Iqqi = 0 / 1) Ny / END / Pyy
  qq = local input port (00...01 APA12 / API12)
  i = input number (0...7)
  y = line number (0...999)
  yy = program number (0...99)

- **Actual position**

  – greater / less than specified value, direct:
  JMP (IP > / < x) Ny / END / Pyy

  – greater / less than specified value, via variable
  JMP (IP > / < Hxx) Ny / END / Pyy
  x = position to be compared [distance unit]
  xx= variable index (00 ...99)
  y = line number (0...999)
  yy = number of program to be called

- **Target position**

  – greater than / reached / less than value, direct:
  JMP (SP > / = / < x) Ny / END / Pyy
  greater than / reached / less than, via variable
  JMP (SP > / = / < Hxx) Ny / END / Pyy

x = position to be compared [distance unit]
xx = variable index (00...99)
y = line number (0...999)
yy = number of program to be called

- **Target position reached and actual position (not/) in position window**

  – **`JMP (PW = 0 / 1) Ny / END / Pyy`**
  y = line number (00...999)
  yy = program number (0...99)

- **Status of an (indexed) logic flag**

  – Status 0 / 1:
  `JMP (Mxx = 0 / 1) Ny / END / Pyy`
  `JMP (M [Cxx] = 0 / 1) Ny / END / Pyy`
  xx = flag index (00 ... 99)
  Cxx = indexed flag index (00 ... 99)
  y = line number (0...999)
  yy = number of the program to be called (0 ... 99)

Flags are set with the commands **`SET Mxx = ... .`**

- **Counter value**

  – greater than / reached / less than value
  `JMP (Cxx > / = / < d) Ny / END / Pyy`
  xx = counter index (00...99)
  d = counter value to be compared (0 ... 65535)
  y = line number (0 ... 999)
  yy = number of program to be called (00 ... 99)

Counters are set with the commands **`SET Cxx = ... .`**

- **(Indexed) variable value**

  – greater than / reached / less than value, direct:
  `JMP (Hxx > / = / < z) Ny / END / Pyy`
  `JMP (H[Cxx] > / = / z) Ny / END / Pyy`
  – greater than / reached / less than, via variable:
  `JMP (Hxx > / = /< Hzz) Ny / END / Pyy`
  xx = variable index (00...99)
  z = variable value to be compared
  zz = index of variable to be compared (00 ... 99)
  Cxx = indexed variable index (00 ... 99)
  y = line number (0...999)
  yy number of program to be called (00 ... 99)

Variables are set with the commands **`SET Hxx = ... .`**

- **Timer value**

  greater than / reached / less than:
  JMP (Zxx > / < d / = 0) Ny / END / Pyy
  xx = timer index (00...07) *)
  d = timer value to be compared (0...65535)
  y = line number (0...999)
  yy = number of program to be called (00 ... 99)

Timers are set with the commands **SET Zxx = ...**

*) Status check for identical value only possible if timer has run down (i.e. = “0"), as an interim value (= ”d") may not be reached at the time of status check.

- **Breakpoint**

  not reached / reached:
  JMP (BK = 0 / 1) Ny / END / Pyy
  y = line number (0...999)
  yy = number of program to be called (00 ... 99)

Breakpoints are set with the commands **SET B ... .**

- **Touch Probe**

  not reached / reached:
  JMP (TP = 0 / 1) Ny / END / Pyy
  y = line number (0...999)
  yy = number of program to be called (00 ... 99)

The touch probe logic is activated with the command **SET TP ....**

- **Axis status**

  – axis stopped / axis travelling
  JMP (ST = 0 / 1) Ny / END / Pyy
  y = line number (0...999)
  yy = number of program to be called

7.3.2.2 Set commands

- **Digital output**

– direct:
SET Oxxx = 0 / 1
– as mask:
SET Ozz = Pyy
zz = output port (= 00)
yy = output mask (hexadecimal)

– as counter
SET Ozz = Cxx

xxx =	000	001	002	003	004	005	006	007
Output terminal	X11/22	X11/23	X11/24	X11/25	X11/26	X11/27	X11/28	X11/29

Important:
"xxx" values other than the ones above are reserved for future revisions!

- **CAN commands**

– SET :a: ... An optional axis identifier :a: may be entered after the command word SET in all SET commands:
a: 0 ... 7: axis number
@: broadcast message (to all axes including the host
(exception: SET BRAKE = 0 / 1 only works for the host axis):

Since CAN messages are processed in-between program lines it is important to ensure that an axis is not continuously sent messages from several axes. If the processing speed of the receiving axis is insufficient, the receive buffer may overflow generating a fault.

- **Digital output port**

  – AND input / OR input / flag / output and input / flag / output:
  SET Oppo = (Iqqi / Mxx / Orrk & / | I rrk / Myy / Oqqi)
  pp = local output port (00 = APA 12 / API 12)
  o = output number (0 ... 7)
  qq, rr = local input port (00 ... 01 = APA 12 / API 12)
  i, k = input number (0 ... 7)
  xx, yy = index (0 ... 99)

  – Setting to flag
  SET Oppo = Mxx
  xx = index (0 ... 99)

– Setting a mask for port pp to flag Cxx
SET Oppo = Cxx
xx = index (0 ...99)

- **(Indexed) logic flag**
  – direct / to flag Myy / to flag Myy negated:
  SET Mxx = 0 / 1 / Myy / - Myy
  SET M [Cxx] = 0 / 1 / Myy / - Myy
  xx, yy = flag index (00 ... 99)
  Cxx = indexed variable index (00 ... 99)

  – AND input / OR input / flag / output and input / flag / output
  SET Mxx = (Iqqi / Myy / Orrk & / | Irrk / Mzz / Oqqi)
  SET M {Cxx] = (Iqqi / Myy / Orrk & / | Irrk / Mzz / Oqqi)
  xx, yy, zz = flag index (00 ... 99)
  qq, rr = local input port (00 ... 01 APA 12 / API 12)
  i, k = input number (0 ... 7)
  Cxx = indexed variable index (00 ... 99)

The status of logic flags is read with the commands **JMP (Mxx ...)**

- **(Indexed) variable**
  – direct / to variable / to indexed variable / to counter / to table position:
  SET Hxx = y / Hyy / H[Cyy] / Cyy / Tyy
  SET H[Cxx] = y / Hyy / H[Cyy] / Cyy / Tyy
  xx = variable index (00...99)
  y = value to be set (-2^{30} ... $+2^{30}$)
  yy = index for variable / counter / table position
  Cyy = indexed variable index (00 ... 99)

  – actual position / target position / override / touch probe position
  SET Hxx = IP / SP / OV / TP
  SET H [Cxx] = IP / SP / OV / TP

  – calculating by way of addition / subtraction / multiplication / division *) of/by y / 2nd variable
  SET Hxx + / - / * / : y / Hyy
  SET H [Cxx] + / - / * / : y / Hyy
  xx, yy = variable index (00 ...99)
  y = value for calculation with Hxx

Variables are read with the commands **JMP (Hxx ...)**

*) y / Hyy = 0 is not permitted (division by 0!)

- **Counter**
  – direct / to variable / to counter / to input port / to output port:
  SET Cxx = d / Hyy / Cyy / Iqq / Opp
  xx = counter index (00...99)
  d = value to be set (0 ... 65535)
  yy = index for variable / counter
  qq = local input port (00 ... 01 APA 12 / API 12)
  pp = local input port (00 APA 12 / API 12)

– calculation by adding / subtracting / variable
SET Cxx = + / - y / Hyy
xx = counter index (00...99)
yy = index of variable , whose value is to be added to /subtracted/from Cxx
y = value to be added to/subtracted from Cxx (1...65535)

Counters are read with the commands **JMP (Cxx ...) .**

- **Table position** (indexed)

– direct / to variable / to actual position / to target position
SET Txx = d / Hyy / IP / SP

– direct / to variable / to actual position/ to target position
SET T [Cxx] = d / Hyy / IP / SP
xx = table position index (00..15)
d = table position value (-2^{30}...$+2^{30}$)
yy = variable index (00...99)

- **Timer**

After setting a timer its value is automatically decreased by one every millisecond until the timer has run down to zero.

– direct / via variable
SET Zxx = d / Hyy
xx = timer index (00...07)
d = value to be set (0...65535)
yy = variable index (00...99)

Timers are read with the commands **JMP (Zxx ...).**

- **Breakpoint**

A breakpoint is used to detect and monitor when and whether a certain position has been reached. A breakpoint is set directly or via a variable. The position is monitored with WAIT commands or a status check. If the breakpoint is reached, any user-specified action can be carried out.

– absolute / (relative) direct / via variable
SET BA / BR = x / Hyy
x = absolute breakpoint value [distance unit]
yy = variable index (00...99)

Breakpoints are read with the commands **JMP (BK = ...)** and **WAIT BK.**

Important:
When using the **SET BR** commands the axis concerned must be stopped. You may, however, always set an absolute breakpoint with **SET BA.**

- **Touch probe**

  – **SET TP**

A touch probe is read with the commands **JMP (TP= ...).**

- **Accept reference position**
  This command sets the current **actual position** to the value of the zero offset defined in the machine parameters.

  – **SET 0**

- **Zero offset**
  this command sets the current **target position** to the value of the zero offset defined in the machine parameters

  – **SET NP**

- **Zero pulse logic**
  By activating the zero pulse logic the system will go to the zero pulse of the encoder. Status check is the same as for the touch probe JMP (TP = ...).

  – **SET NL**

- **Set target position**
  This command sets the current target position to the value of x or Hyy, the actual position is offset by the prevailing lag error.

  – **SET SP = x / Hyy**

- **Set actual position**
  This command sets the current actual position to the value of x or Hyy, the target position is offset by the prevailing lag error.

- **Override**
  If programmed accordingly, the override function can also be activated/deactivated via an input terminal. Activation via an input terminal and via the program is through an OR operation in the unit. If use of the override results in a final speed greater than the maximum speed programmed in the machine parameters, the speed will be limited to the programmed maximum speed.

Note

If acceleration and deceleration ramps are set to the same value and if a linear accel./decel. type is selected, the override is taken into account throughout the execution of the travel command. If the $\sin^2$ accel./decel. type is active, or if the ramps for linear accel./decel. are set to a different value, the override is only read in at the beginning of each travel command.

If the override is activated the programmed speeds for all positioning operations are multiplied by the override value passed by the servo module (0...150 %).

If the override is deactivated, travel is always at the programmed speed (corresponds to override = 100 %).

– activate / deactiate
SET OV = 1

Weighting of machine parameters

Note
These commands do not change the machine parameters but only their weighting factors. After the supply is connected and the machine parameters are transmitted, the weighting factors are set to 100%.

- **Type of acceleration/deceleration**

  – linear accel./decel. / sin^2 accel./decel.:
  SET K15 = 0 / 1

- **Weighting the acceleration/deceleration**

  – max. accel./decel. direct / via variable:
  SET K16 / K17 = d / Hyy
  y = value to be set (1 ... 100%)
  yy = variable index (00 ... 99)

  – sin^2 form factor accel./decel.
  SET K26 / K27 = y / Hyy
  y = value to be set (1 ... 100%)
  yy = variable index (00 ... 99)

- **Controller gain**

  – direct / via variable:
  SET K40 = d / Hyy
  d = value to be set (1 ... 100%)
  yy = variable index (00 ... 99)

- **Setting the brake**

  – **SET BRAKE = 0 / 1**

  Sequence of operation:

  BRAKE = 0
  1. Target position is set to actual position.
  2. Output stage is enabled. Position control is active.
  3. Terminal X21/9 is driven to HIGH (brake is released).
  4. At the end of the brake reaction time (P501) the next command is executed

BRAKE = 1
1. The drive decelerates with active deceleration ramp (STOP B).
2. When standstill of the axis is detected (axis in position window) terminal X21/9 is driven LOW (brake is applied).
3. The drive remains under position control until time (P501) has run out.
4. The output stage is disabled, the position control switched off.

Note:
When the brake is applied, a deviation between the current target position and the target position effective before SET BRAKE = 1 may occur (e.g. due to wear). This fact must be taken into account in particular when a relative positioning operation is to be performed afterwards. Resultant positioning errors can be avoided in the program, as in the following example:

```
GOW    Ax Vy     ; positioning command with WAIT option
SET    Hxx = SP  ; save target position
SET    BRAKE = 1 ; apply brake
...
...
SET    BRAKE =0  ; release brake
SET    Hxx+Hyy   ; calculating the new target position by adding saved target
                 ; position (Hxx) and distance to be travelled (Hyy)
GOWA   Hxx Vy    ; absolute instead of relative positioning to calculated new target
                 ; position
```

7.3.2.3 Position and travel commands

Reference travel

GO 0

The reference travel is performed in accordance with the reference travel type (K30) and the speeds (K32...K34) defined in the machine parameters (see section 3).
If this command is included in a program, the following program line will only be executed after the reference travel has been completed.

Travelling to a certain position (absolute) / travelling a certain distance (relative)

Absolute target position or distance travelled and, if required, speed are specified either as fixed values or as variables in any combination.

You can also specify whether you want a command executed with or without program continuation afterwards.

– Positioning with program execution continued **(GO ...)**
  If this command is given within a program, the program execution continues with the following program line while the axis is in motion. This allows for parallel program execution.
  If the command is given during an ongoing positioning operation, the speed will change to the speed transferred and the axis will travel to the new position.

– Positioning with program execution suspended **(GOW ...)**
  With these commands, execution of the program line following this command is suspended until the position target window has been reached.

- **with continuation, position / distance direct, speed direct / via variable**

  - **GO Ax / Rx Vy / Hyy**
    x = position value [distance unit]
    y = speed value [speed unit]
    yy = index of variable with speed value

- **with continuation, position / distance via variable, speed direct / via variable**

  - **GO A / R Hxx Vy / Hyy**
    xx = index of variable with position value
    y = speed value [speed unit]
    yy = index of variable with speed value

- **without continuation, position / distance direct, speed direct / via variable**

  - **GOW Ax / RX Vy / Hyy**
    x = position value [distance unit]
    y = speed value [speed unit]
    yy = index of variable with speed value

- **without continuation, position / distance via variable, speed direct / via variable**

  - **GOW A / R Hxx Vy / Hyy**
    xx = index of variable with position value
    y = speed value [speed unit]
    yy = index of variable with speed value

Positioning to table position

These travel commands are used to travel, at the specified speed, to the table positions whose index is read at the configured input terminals.

- **with continuation, position / distance direct, speed direct / via variable**

  - **GOT A / R Vy / Hyy**
    y = speed value [speed unit]
    yy = index of variable with speed value

- **without continuation, position / distance direct, speed direct / via variable**

  - **GOTW A / R Vy / Hyy**
    y = speed value [speed unit]
    yy = index of variable with speed value

Positioning with touch probe

With these commands the axis will always travel relative to the actual position read when the "touch probe" signal is received. Before execution, the "touch probe" logic must be activated with the **SET TP** command and the "touch probe" signal received (Sec. 7.3.2.1).

Note on using the touch probe commands

If the axis is to execute the commands **GOTP (W) Rxxx Vyyy**
when the touch probe signal is received, enter the following command string:

```
      .....
      WAIT TP
      GOTP (W) Rxxx Vyyy
      .....
```

Replacing **WAIT TP by SET TP** will generate undefined events.
If you want to use **SET TP**, you will have to replace **WAIT TP** by the following command string.

```
      .....
      SET TP
Nxxx  JMP (TP = =) Nxx
      GOTP (W) Rxxx Vyyy
      .....
```

In Section 8.4 you will find an example explaining the use of the touch probe in connection with variable positioning.

- **with continuation, distance direct / via variable, speed direct / via variable**

  – **GOTP Rx / R Hxx Vy / Hyy**
  x = position value [distance unit]
  xx = index of variable with position value
  y = speed value [speed unit]
  yy = index of variable with speed value

- **without continuation, distance direct / via variable, speed direct / via variable**

  – **GOTPW Rx / R Hxx Vy / Hyy**
  x = position value [distance unit]
  xx = index of variable with position value
  y = speed value [speed unit]
  yy = index of variable with speed value

- **continuous travel, positive / negative direction, speed (direct) / via variable**

  – **GO V +y / -y / Hyy**
  y = speed value [speed unit]
  yy = index of variable with speed value

  The sign of the value in Hyy determines the direction of travel.

- **Deceleration**

  – with programmed deceleration
  STOP B
  Deceleration along the deceleration ramp defined in the machine parameters with subsequent position control after reaching zero speed.

  – with maximum deceleration
  STOP M
  Deceleration at the MOVIDYN® current limit, i.e. with maximum possible deceleration. The speed controller of the MOVIDYN® is given a speed setpoint of zero. After reaching zero speed the position control becomes active.

  – zero output
  STOP 0
  As the **STOP M** command, however without position control after reaching zero speed. The speed controller is only given a speed setpoint of zero, whereby the system is only speed-controlled.

Important
After the unit is enabled by the controller inhibit, the position control remains inactive until a positioning command or **STOP B** or **STOP M** command is given.

7.3.2.4 Wait commands

Time

These commands suspend program execution for a certain time (in milliseconds) or event. After the set time has elapsed or the required condition is met, program execution is resumed in the next line.

– **WAIT x / Hxx / (Ixx = 0 / 1)**
x = wait time (1...65535) [ms]
xx = index of wait time variable
xxx= input terminal index; program execution is continued if the respective input has the requested level (0 or 1). (→Table on page 96)

- **Breakpoint**

  – **WAIT BK**
  A breakpoint must be set before with the command **SET B...** .
  Program execution will only be continued if the actual position is the position specified by the command **SET B...** .

- **Touch probe**

  – **WAIT TP**
  Automatically executes the **SET TP** command, thus activating the touch probe logic.
  Program execution will continue only after the touch probe signal is received.

- **Axis stopped**

  – **WAIT ST**
  The program is continued when the calculated setpoint position is the same as the target position; the actual position may still be outside the position window.

- **Target position reached / actual position in position window**

  – **WAIT PW**
  The program waits until the drive has reached the set target position by way of calculation and the actual position is in the position window:
  PW = target position ± K24 (position window)
  Explanation: GOW commands allow program continuation when the target position has been reached by way of calculation in the processor. In high dynamic applications, the actual position may still not be equal to the target position due to a lag error. The **WAIT PW** command will allow the program to be continued only after the actual position is within the position window.

- **Encoder zero**

  – **WAIT NL**
  The **WAIT NL** works similar to the **WAIT TP** command, the trigger signal being the internal encoder zero instead of the touch probe input. The **WAIT NL** preset command is executed with the command **GO TP (W) ... .**

7.3.2.5 Status commands

- **Status request via the serial interface**

  – **?**

In the [Manual mode], [Reference travel] and [Status display] menu options of the MD_POS user software, the "**?**" command is constantly sent to the axis to provide a display of the values in the axis. The axis replies with the following values:

Acknowledgement:	**G ...**	actual position	distance units (decimal)
	H ...	target position	distance units (decimal)
	O ...	lag distance	increments (decimal)
	I ...	LM628 status register	hexadecimal, 4-digit
	J ...	override	% (decimal)
	K ...	digital inputs	hexadecimal, 4-digit
	L ...	digital outputs	hexadecimal, 2-digit
	M ...	current program number	decimal
	N ...	current line number	decimal
	P ...	hardware limit switch	decimal, 1-digit
		where	1 = no limit switch actuated
			2 = pos. limit switch actuated
			3 = neg. limit switch actuated
			4 = both limit switches actuated

All values may be inquired individually; fault messages are not returned.

For a more detailed discussion of the status command, refer to the "APA 12 / API 12 Communications Interface" documentation.

7.4 Variables

Variables are used to save position, counter and timer values.
The variables comprise a value range of 32 bits. They are set and reset via the serial interface or a travel program and read in individual commands. There are 100 variables available. All variables are written to the flash EPROM when the data are stored.

For control, purposes variables can be displayed in the MD_POS status window and their values monitored on line (section 5.2).

The [Variable] option of the [Parameter] menu will display all 100 variables (variables 00 to 99) in five submenus.

The variables are either

– set by the program and entered in this file
  or
– specified by the programmer of the travel program. The program will then read the variables from the file.

If required the variables can be viewed, entered or edited as follows:

- Select the [Variables] option of the [Programming] menu.
  You will be asked to specify where the variables are to be loaded from.

Either:

- Select [New] to create a new variable file.
  The first page of the [Variables] file (variables 0 to 19) is displayed.

Or

- Select [Axis] to edit or view the variables of an installed APA 12/API 12. You will be prompted to enter the axis number.

- Enter the desired axis number and click [OK] to confirm your choice.
  The first page of the [Variables] file (variables 0 to 19) is displayed.

Or

- Select the [Disk] option to view and/or edit a file stored on your hard disk. You will be prompted to specify the file name. The file extension is always **.VAR.**

- Select the desired file from the file selection list and confirm by clicking the [Open] button.
  The first page of the [Variables] file (variables 0 to 19) is displayed.

- Use the PgUp/PgDn keys to select the page displayed.

  variables 20 to 39 page 2

  variables 40 to 59 page 3

  variables 60 to 79 page 4

  variables 80 to 99 page 5

See section 5.2 for a description of the submenu.

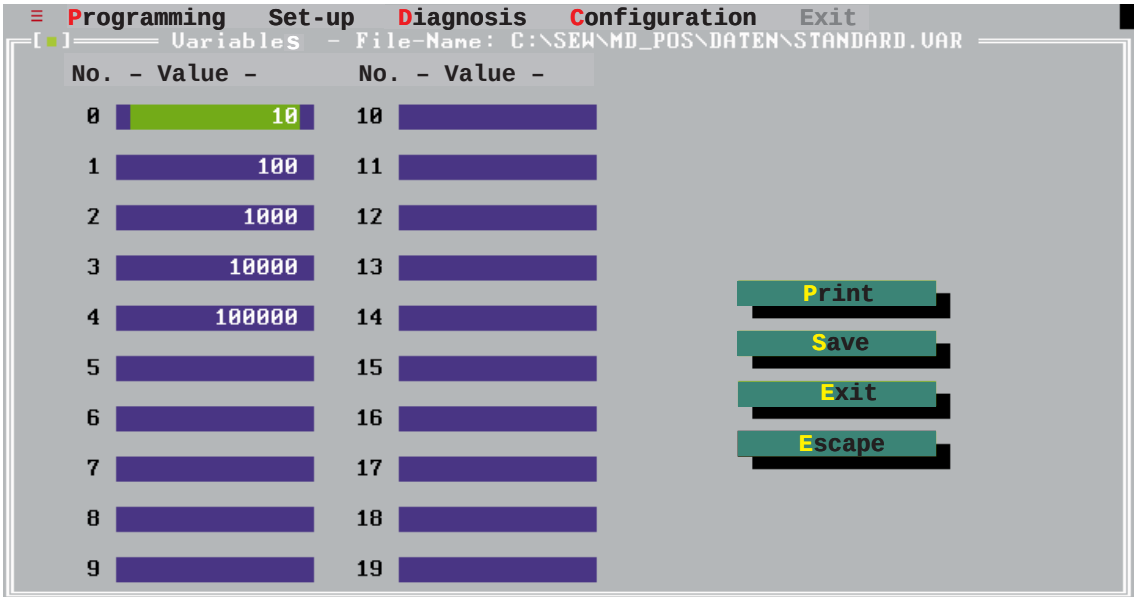


Fig. 60 Variables submenu (page 1) 000128AEN

- Enter a new variable value or edit existing values to suit the requirements of your travel program.
- When you are finished editing select [Exit].
  The program will then ask you to specify where to save the data to.
- Select where to save the data to.

You can either:

- Select [Disk] if you wish to save the data to the hard disk of your PC.
  You will be prompted to enter a file name.
- Enter a file name. The file extension is always **.VAR**.
- Select [Save].
  The file will be saved. This will take you back to the main menu level.

or

- Select [Axis] if you wish to send the variables to the APA 12/API 12 positioning control.
  You will be prompted to enter the axis number:
- Enter the axis number and click [OK] to confirm.
  The variables will be sent to the APA 12/API 12. This will take you back to the main menu level.

7.5 Table positions

The [Table pos.] option of the [Programming] menu allows for 16 position values to be entered (0 to 15).

Table positions are used in conjuction with the input terminal assignment. If a maximum of four adjacent terminals are marked with an “X” in the [table index] line of the machine parameter menu (page 1), the program will read the table position (binary coded) based on the corresponding input status H (=1) or L (0) and instruct the axis to travel to the position specified.

Value				Assigned table position
2^3	2^2	2^1	2^0	
0	0	0	0	Pos. 0
0	0	0	1	Pos. 1
0	0	1	0	Pos. 2
0	0	1	1	Pos. 3
0	1	0	0	Pos. 4
0	1	0	1	Pos. 5
0	1	1	0	Pos. 6
0	1	1	1	Pos. 7
1	0	0	0	Pos. 8
1	0	0	1	Pos. 9
1	0	1	0	Pos. 10
1	0	1	1	Pos. 11
1	1	0	0	Pos. 12
1	1	0	1	Pos. 13
1	1	1	0	Pos. 14
1	1	1	1	Pos. 15

Table: Table positions

Enter/edit table positions

To enter/edit table positions proceed as follows:

- Select [Programming].
- Select [Table pos.]
  You will be prompted to specify where the table positions are to be retrieved from:

Either:

- Select [New] if you wish to create a new table position file. The table position display (0 to 15) will appear.

or

- Select [Axis] if you wish to edit or view the table position of an installed APA 12/API 12. You will be prompted for the axis number.

- Enter the desired axis number and click [OK] to confirm your choice.
  The table position submenu (0 to 15) will appear.

or

- select [Disk] if you wish to view and/or edit a file stored on your hard disk. You will be prompted to specify the file to be opened. The file extension always is **.TAB**.
- Select the desired file from the file selection list and confirm by clicking the [Open] button. The table position submenu will appear (0 to 15).

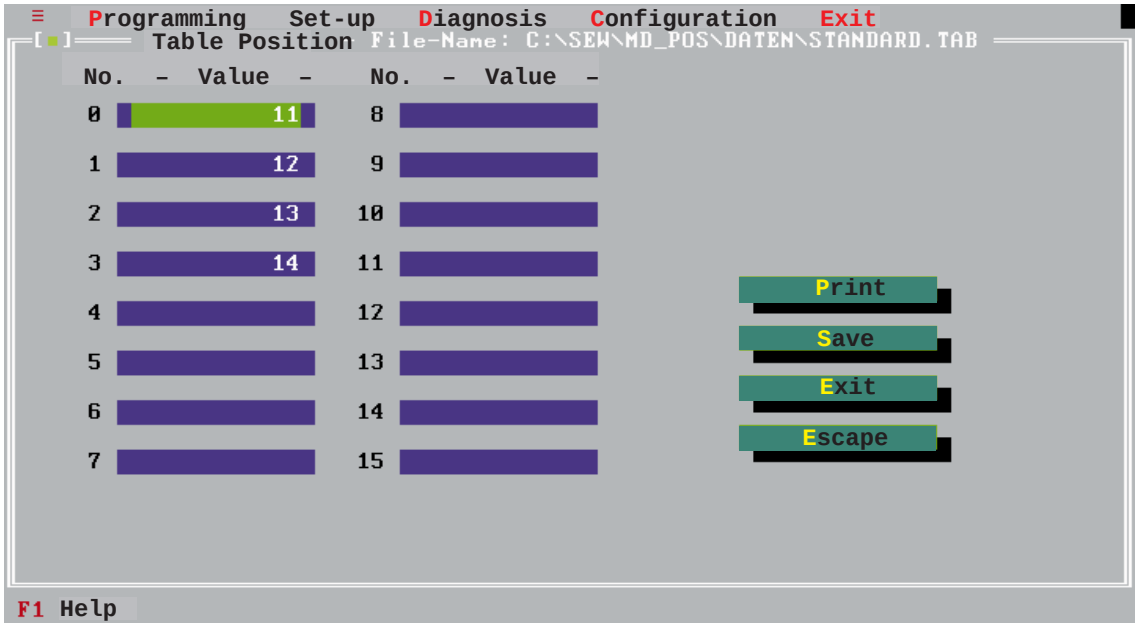


Fig. 61: Table position submenu 00129 AEN

- Enter the new table position values in accordance with the travel program you have written or edit existing values.
- Select [Abort].
  The “Save data” prompt will appear.
- Select where to save the data to:

Either

- Select [Disk] if you wish to save the data to the hard disk of your PC.
  You will be prompted to enter a file name.
- Enter a file name. The file extension is always **.TAB**.
- Select [Save].
  Your file will be saved. This will take you back to the main menu level.

or

- Select [Axis] if you wish to send the variables to the APA 12/API 12 positioning control.
  You will be prompted to enter the axis number:

- Enter the axis number and click [OK] to confirm.
  The table positions will be sent to the APA 12/API 12. This will take you back to the main menu level.

7.6 Flags

Flags are logic variables, which can have only one of two values (0 or 1). Flags are used to remember a certain condition and can be read with the **JMP (M..)** commands.

All flags are set to zero when the system is powered up. Flags retain their value until they are overwritten by a new program command. Flags set in one program can be read in another program. There are 100 total flags available (M00...M99). For control purposes flags can be displayed in the MD_POS status window and their values monitored on-line (see section 5.2).

7.7 Counters

Counters are variables with a value range of 16 bits (0...65535). As a rule, they are used to count certain events and can be read with the **JMP (C..)** commands. There are also special commands to set counters. There are a total of 100 counters (C00...C99) available. Counters cannot be stored in non-volatile memory and are therefore set to 0 on power up.

7.8 Timers

Timers are variables set by a program and counted down by the APA 12/API 12 system at intervals of 1 ms until a value of zero is reached. The timers have a value range of 16 bits (0...65535), allowing for a waiting time of up to 65.535 seconds. There are special commands for setting and inquiring timers. There are a total of 8 timers (Z00...Z07) available.

When a value of zero is reached, the timer has run down and stops.

7.9 Program examples

The following section discusses various examples showing how a set task is implemented. For a detailed description of the commands used see section 7.3.2.

Task 1:

– The axis is at position 0 and shall travel to position 10000.
– An output shall be set at position 6000.
– The program shall end when the axis has reached the target position.

Entry:

```
%P01 (Breakpoint)
N005 SET 0                ; current position = home position
N010 GO A10000 V100       ; abs. positioning with continuation
N020 SET BA = 6000        ; set abs. breakpoint
N030 WAIT BK              ; wait for breakpoint
No40 SET 0001 = 1         ; when BK is reached, set output 1 = 1
N050 WAIT ST              ; wait until target position 10000 is reached
END                       ; End
```

Note: The breakpoint logic can also be set before the travel command.

Task 2:

– The axis is at position 0 and shall travel to position 10000.
– Between position 4000 and 6000 an input is to be monitored.
– If within the specified range a high level is present at this input, the axis is to stop immediately and the program is to terminate. Otherwise, the program shall end on reaching the target position.

Entry:

```
%P02 (Monitoring of range)
N005 SET 0                ; current position = home position
N010 GO A10000 V100       ; abs. positioning with continuation
N020 SET BA = 4000        ; set abs. breakpoint
N030 WAIT BK              ; wait for breakpoint
N040 SET BA = 6000        ; set new abs. breakpoint
N050 JPM (I010 = 0) N80   ; conditional jump if input 10=0
N060 Stop M               ; stop with max. deceleration
N070 JMP END              ; jump to program end
N080 JMP (BK=0) N50       ; conditional jump if BK not reached
N090 WAIT ST              ; wait until target position 10000 is reached
END                       ; End
```

Task 3:

– An axis shall continuously travel between position 0 and the selected table position.
– If the position is greater than 100000, an output is to be driven high.

Entry:

```
%P06  (Table)
N001  JMP P50              ; jump to program no. 50
N005  SET 0                ; current position = home position
N006  WAIT 100             ; pause 100 ms
N010  SET 0007 = 0         ; output 7 = 0
N020  SET BA = 100000      ; set abs. breakpoint
N030  GOTA V1000           ; abs. table positioning with continuation
N040  JMP (BK = 1) N100    ; conditional jump if BK reached
N050  JMP (ST = 0) N40     ; conditional jump if tab. pos. not yet reached
N060  JMP N200             ; abs. jump to line 200
N100  SET 0007 =1          ; set output 7 = 1
N110  SET BA = 100000      ; set abs. breakpoint again
N120  WAIT ST              ; wait until table position is reached
N200  GO A0 V1000          ; abs. positioning with continuation
N210  JMP (BK = 1) N300    ; cond. jump if BK is reached
N220  JMP (ST = 0) N210    ; cond. jump if home pos. not reached yet.
N230  JMP N20              ; abs. jump to line 20 (loop)
N300  SET 0007 = 0         ; set output 7 = 0
N310  WAIT ST              ; wait until table position is reached
N320  JMP N020             ; abs. jump to line 20 (loop)
END                        ; End


%P50  (Load table) ...     ; program no. 50
N10   SET T00 = 10000      ; set table position
N20   SET T01 = 20000
N30   SET T02 = 30000
N40   SET T03 = 40000
N50   SET T04 = 50000
N60   SET T05 = 60000
N70   SET T06 = 70000
N80   SET T07 = 0
N90   SET T08 = 90000
N100  SET T09 = 100000
N110  SET T10 = 110000
N120  SET T11 = 3800
N130  SET T12 = 130000
N140  SET T13 = 140000
N150  SET T14 = 150000
N160  SET T15 = 160000
END                        ; End
```

Task 4:

– The binary code present at 4 input terminals determines how many times a subroutine (P51) will be called.

Entry:

```
%P03 (Cycles)
N005 SET 0                  ; current position = home position
N010 SET C00 = 0            ; counter is set to zero
N020 JMP (I014 = 0) N30     ; read value 20 at X11/18
N025 SET C00 +1             ; transfer value to counter C00
N030 JMP (I015 = 0) N40     ; read value 21 at X11/19
N035 SET C00 +2             ; transfer if X11/19 = 1
N040 JMP (I016 = 0) N50     ; read value 22 at X11/20
N045 SET C00 +4             ; transfer if X11/20 =1
N050 JMP (I017 = 0) N60     ; read value 23 at X11/21
N055 SET C00 +8             ; transfer if X11/21 =1
N060 JMP (C00 =0) END       ; jump to program end if value = 0
N070 JMP P51                ; call program no. 51
N080 SET C00 -1             ; decrement travel counter
N090 JMP (C00 > 0) N70      ; travel again if C00 =0
END                         ; End
%P51 (BACK AND FORTH)
N10  GOW R10000 V1000       ; subroutine no. 51 with
N20  GOW R-10000 V1000      ; relative positioning without continuation
END                         ; End
```

Task 5:

– An output shall be driven high for a period of 35 seconds.
– During this time a second output shall blink at a frequency of 1 Hz.
– After 35 seconds both outputs must be driven low immediately.

Entry:

```
%P04 (Time)
N010 SET 0006 =1            ; set output 6 = 1
N020 SET Z00 = 35000        ; start timer 35s
N030 SET 0007 = 1           ; set output 7 = 1
N040 SET Z01 = 500          ; start timer 0.5s
N050 JMP (Z00 = 0) N200     ; cond. jump. if 35s over
N060 JMP (Z01 > 0) N50      ; cond. jump if 0.5s not over
N070 SET 0007 = 0           ; half-cycle ended with X11/29 = 0
N080 SET Z01 = 500          ; set again for second half-cycle
N090 JMP (Z00 = 0) N200     ; cond. jump. if 35s over
N100 JMP (Z01 > 0) N90      ; cond. jump if 0.5s not over
N110 JMP N30                ; second half-cycle finished
N200 SET 0006 = 0           ; 35s over outputs 6 and
N210 SET 0007 = 0           ; 7 are set to “0"
END                         ; End
```

Task 6:

– An axis shall travel until a pressure mark is identified. The sensor to detect the pressure mark is connected to the touch probe input.

– After receipt of the touch probe signal the axis shall travel for another 10000 distance units without stopping.

– If no touch probe signal is received the axis may travel a maximum of 60000 distance units.

– The program ends when the axis has stopped.

Entry:

```
%P05 (Touch Probe)
N005 SET 0                ; current position = home position
N010 GO R60000 V500       ; relative positioning with continuation
N020 SET TP               ; activate TP input
N030 JMP (TP = 1) N100    ; conditional jump if TP input =1
N040 JMP (ST = 1) END     ; jump to program end if 60000 is reached
N050 JMP N30              ; loop
N100 GO TPW R10000 V100   ; rel. pos. 10000 by TP signal without continuation
END                       ; End
```

8 Application Notes

8.1 Wiring diagrams

The following diagrams show two wiring examples for the 24V power supply.

8.1.1 Connection of the APA 12/API 12 with internal 24V power supply

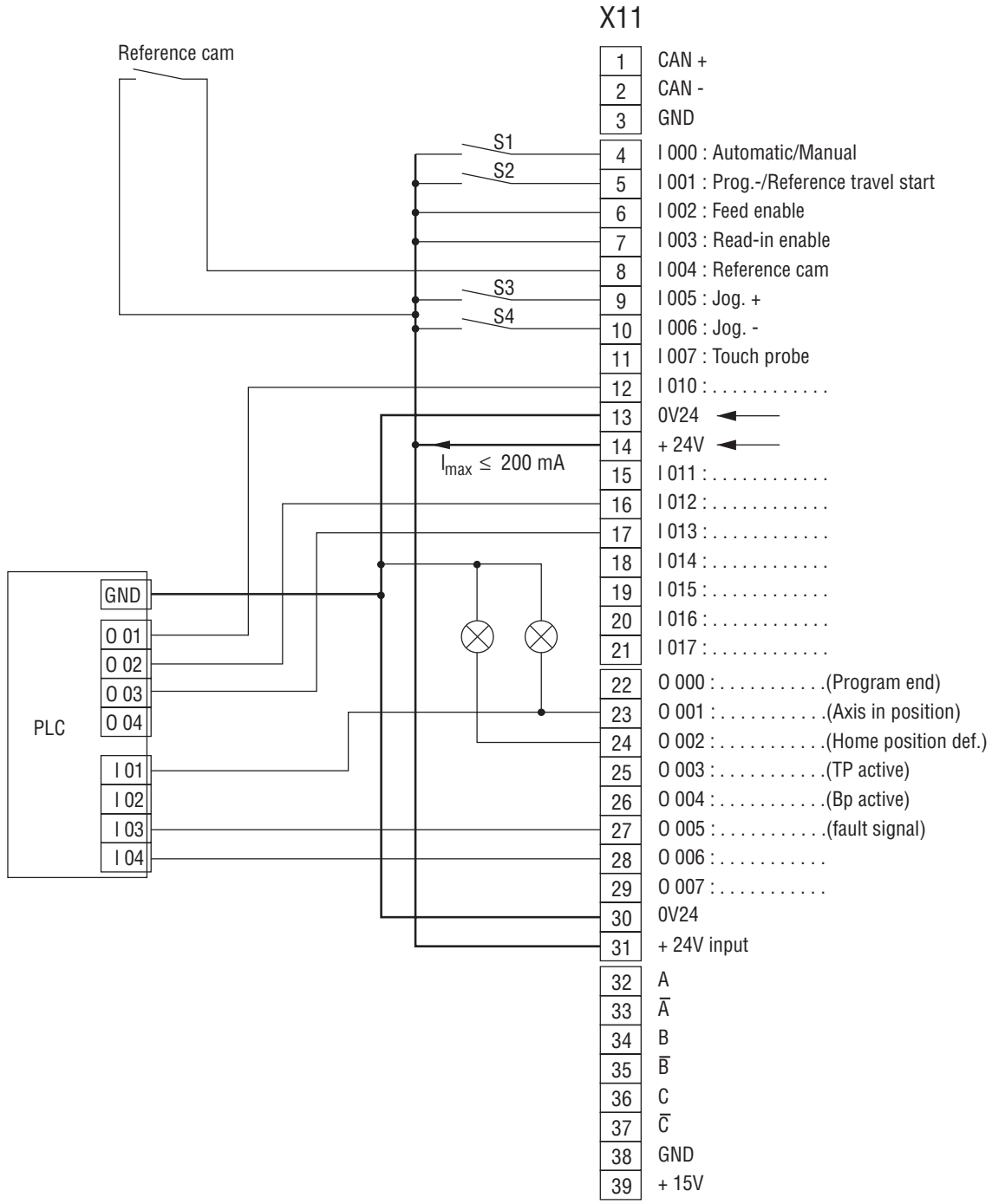

X11
Reference cam
S1
S2
S3
S4
$I_{max} \leq$ 200 mA
PLC
GND
O 01
O 02
O 03
O 04
I 01
I 02
I 03
I 04
1 CAN +
2 CAN -
3 GND
4 I 000 : Automatic/Manual
5 I 001 : Prog.-/Reference travel start
6 I 002 : Feed enable
7 I 003 : Read-in enable
8 I 004 : Reference cam
9 I 005 : Jog. +
10 I 006 : Jog. -
11 I 007 : Touch probe
12 I 010 : . . . . . .
13 0V24
14 + 24V
15 I 011 : . . . . . .
16 I 012 : . . . . . .
17 I 013 : . . . . . .
18 I 014 : . . . . . .
19 I 015 : . . . . . .
20 I 016 : . . . . . .
21 I 017 : . . . . . .
22 O 000 : . . . . . .(Program end)
23 O 001 : . . . . . .(Axis in position)
24 O 002 : . . . . . .(Home position def.)
25 O 003 : . . . . . .(TP active)
26 O 004 : . . . . . .(Bp active)
27 O 005 : . . . . . .(fault signal)
28 O 006 : . . . . . .
29 O 007 : . . . . . .
30 0V24
31 + 24V input
32 A
33 $\overline{A}$
34 B
35 $\overline{B}$
36 C
37 $\overline{C}$
38 GND
39 + 15V

Fig. 62: Wiring example: APA 12 / API 12 with internal 24V supply 00130AEN

8.1.2 Connection of the APA 12/API 12 with internal and external 24V power supply

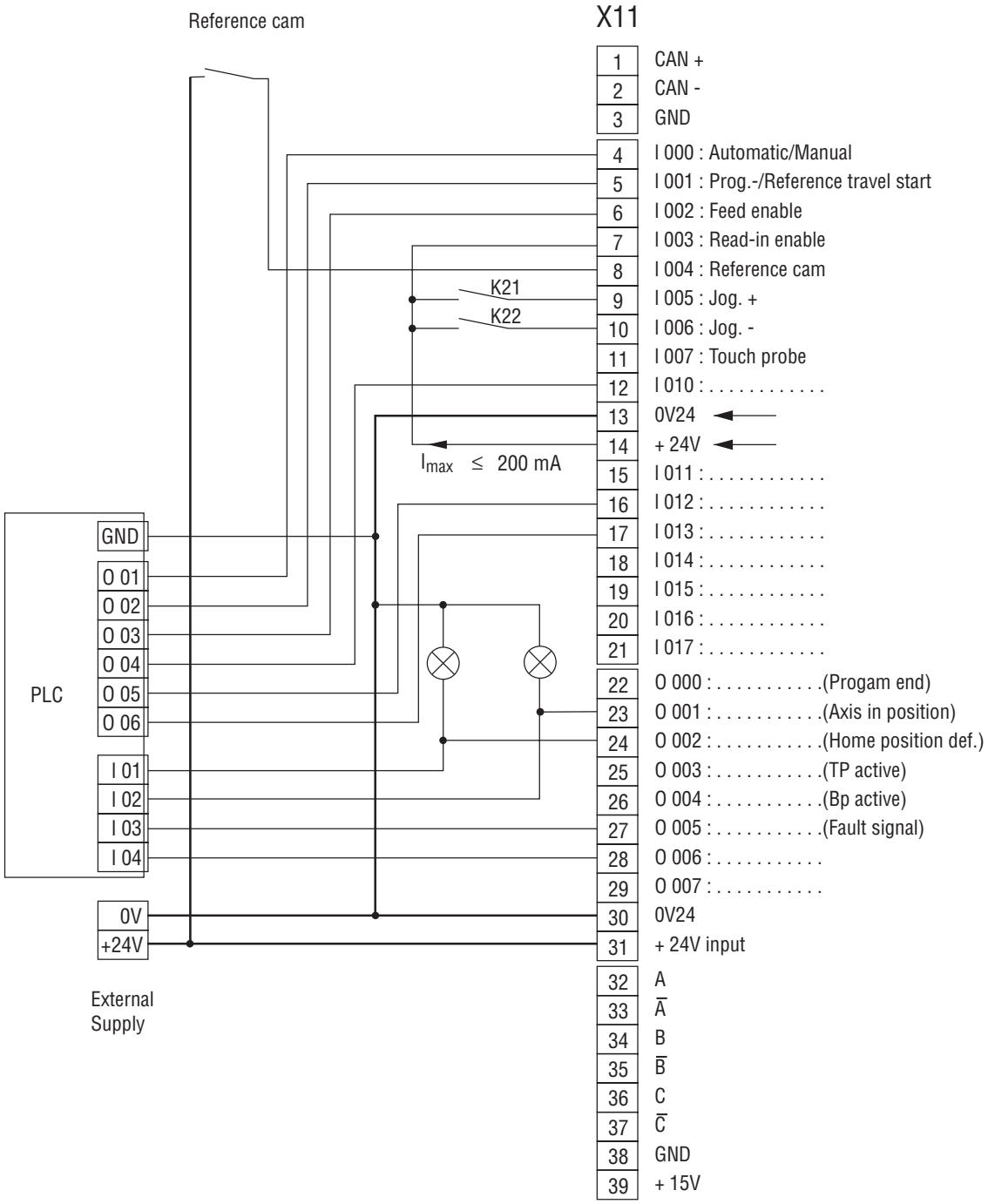

Reference cam
X11
1 CAN +
2 CAN -
3 GND
4 I 000 : Automatic/Manual
5 I 001 : Prog.-/Reference travel start
6 I 002 : Feed enable
7 I 003 : Read-in enable
8 I 004 : Reference cam
9 I 005 : Jog. +
10 I 006 : Jog. -
11 I 007 : Touch probe
12 I 010 : . . . . . .
13 0V24
14 + 24V
15 I 011 : . . . . . .
16 I 012 : . . . . . .
17 I 013 : . . . . . .
18 I 014 : . . . . . .
19 I 015 : . . . . . .
20 I 016 : . . . . . .
21 I 017 : . . . . . .
22 O 000 : . . . . . .(Progam end)
23 O 001 : . . . . . .(Axis in position)
24 O 002 : . . . . . .(Home position def.)
25 O 003 : . . . . . .(TP active)
26 O 004 : . . . . . .(Bp active)
27 O 005 : . . . . . .(Fault signal)
28 O 006 : . . . . . .
29 O 007 : . . . . . .
30 0V24
31 + 24V input
32 A
33 Ā
34 B
35 B̄
36 C
37 C̄
38 GND
39 + 15V
K21
K22
I_{max} ≤ 200 mA
PLC
GND
O 01
O 02
O 03
O 04
O 05
O 06
I 01
I 02
I 03
I 04
0V
+24V
External
Supply

Fig. 63: Wiring example: APA 12/API 12 with internal and external 24V supply 00131AEN

8.2 Example for setting and calculating the machine parameters

8.2.1 General

An example based on a hypothetical application of the APA 12/API 12 is used to explain how to set and calculate the machine parameters.

8.2.2 Description of the positioning task:

- A trolley shall travel on a track with a maximum speed of V_{max} = 2m/s.
  The acceleration time to V_{max} shall be t_{max} = 0.5s.
- The reference cam is located between the two limit switches.
- The machine zero is at a distance of 500 mm from the reference cam, toward the CCW limit switch.
- The higher-level PLC can select a maximum of 7 binary-coded control programs stored in the APA 12/API 12 via terminals 12, 15 and 16.
- Selection of maximum 4 table positions shall also be possible via terminals 17 and 18.
- The override must be externally selectable via terminal 19.
- The PLC must be able to receive the signals “Home position defined” and “Axis in position”.
- In the commands, distances travelled shall be specified in [mm], speeds in [mm/s] and accelerations in [m/s^2].
- The trolley travels a reverse distance of 500 mm per output revolution.
- The gear ratio between motor and output is i = 5.
- The total maximum distance travelled is 1000 mm.
- To sense the distance travelled, the encoder simulation of the axis module with a resolution of 1024 increments/revolution shall be used.

The schematic which follows shows this setup.

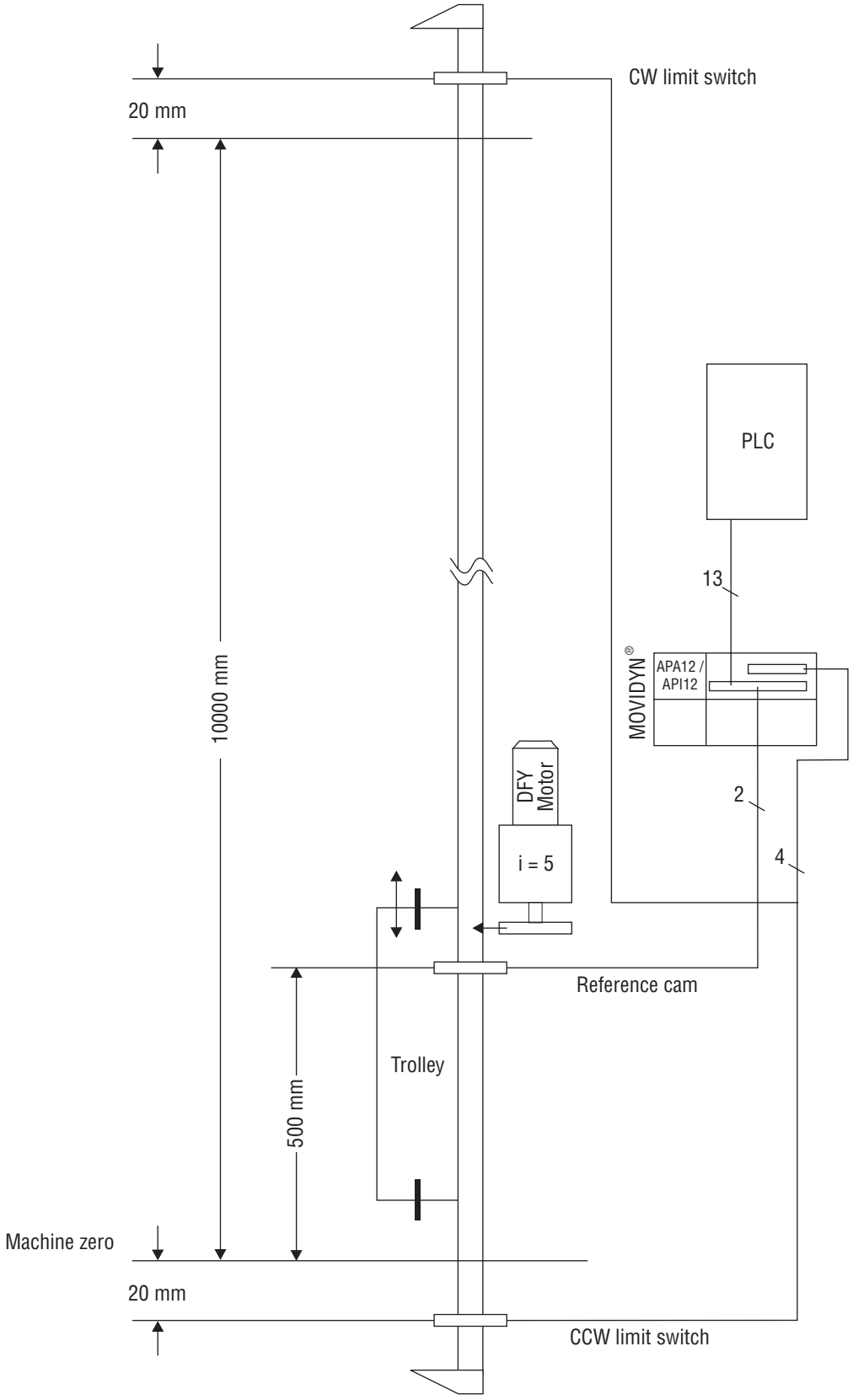


Fig.64: Schematic of system setup

00132AEN

8.2.3 Setting the machine parameters for the sample application

The machine parameters are set in the MD_POS [Machine parameters] menu in accordance with the system configuration (sample application):

K00:	Fixed program number	0	→	program no. selection via terminal
K01:	Program number coding	2	→	binary coded
K02:	Program number selection	07H	→	selection via terminals 12, 15,16
K03:	Table index selection	18H	→	selection via terminals 17, 18
K04:	Override enable selection	20H	→	selection via terminal 19
K05:	Output configuration	06H	→	output “axis in position”, “home position defined”
K10:	Resolution distance numerator	20480	→	see section 3.2.3.1
K11:	Resolution distance denominator	500	→	see section 3.2.3.1
K12:	Resolution speed	915	→	see section 3.2.3.1
K13:	Resolution accel./decel.	313	→	see section 3.2.3.1
K14:	Max. speed	2000	→	2000 mm/s for v_{max}
K15:	Type of accel./decel.	0	→	linear acceleration
K16:	Max. acceleration	4	→	a_{up} = 4m/s^2
K17:	Max. deceleration	4	→	a_{down} = 4m/s^2
K18:	Rapid feed	200	→	V = 200 mm/s
K19:	Creep feed	50	→	V = 50 mm/s
K20:	Zero offset	500	→	x = 500 mm
K21:	Pos. software limit switch	10020	→	+ x_{max} = 10020 mm
K22:	Neg. software limit switch	-20	→	- x_{max} = -20mm
K23:	Lag tolerance	5000	→	in increments
K24:	Position window	20	→	in increments
K25:	Direction encoder	1	→	positive direction
K26:	sin^2 form factor acceleration	1	→	1m/s^2 see section 3.2.3
K27:	sin^2 form factor deceleration	1	→	1m/s^2 see section 3.2.3
K30:	Reference travel type	8	→	see reference travel types section 3.2.4
K31:	Polarity reference cam	1	→	positive edge
K32:	Reference travel speed 1	200	→	mm/s
K33:	Reference travel speed 2	20	→	mm/s
K34:	Reference travel speed 3	5	→	mm/s
K40:	P component	15	→	proportional action factor of the position controller

8.2.4 Calculating machine parameters K10-K13

Important:
If these machine parameters are defined, all subsequent parameters for speed, distance travelled or accel./decel. can be programmed in the chosen units (also see section 3.2.3.1 Machine parameters)!

8.2.5 Resolution of distance travelled (K10/K11)

Requested: Distance in travel commands specified in [mm]

$Z_{API} = Z_{encoder} \cdot 4$

$Z_{encoder}$ = 1024 [increments/revolutions]

$K10 = Z_{API} \cdot 4 \cdot i$

Z_{API} = resolution of the incremental encoder (here: 4096 due to the encoder's 4 x evaluation)

i = gear ratio (here: 5.0)

$K10 = 5 \cdot 4096 =$ 20480 [increments]

K11 = linear distance travelled/output revolution = 500 [mm]

The linear distance travelled is determined based on the diameter of the output gear wheel or a spindle lead.

8.2.6 Speed resolution (K12)

Requested: Speed in travel commands specified in [mm/s]

$$K12 = \frac{22.35 \cdot K10}{K11} = \frac{22.35s \cdot 20480}{500\ mm}$$

K12 = 915s/mm

8.2.7 Resolution accel./decel. (K13)

Requested: Accel./decel. in parameters K16/K17 in [m/sec^2]

$$K13 = \frac{K10}{K11 \cdot 131s^{-2}} = \frac{20480}{500\ mm \cdot 131s^{-2}}$$

$$K13 = 0.313 \frac{s^2}{mm} = 313 \frac{s^2}{m}$$

8.2.8 Accel./decel. K16/K17

Requested: t_{max} = 0.5s/2000mm/s

$$v = a \cdot t \quad \Rightarrow \quad a = \frac{v}{t} = \frac{2\ m/s}{0.5\ s}$$

$$a = 4\ [m/s^2]$$

K16 = 4

K17 = 4

After entering the calculated parameters all data in the machine parameters and the positioning commands can be entered in the units:

- distances travelled in [mm]
- speeds in [mm/s]
- accel./decel. values in [m/s^2].

8.3 Example: Hoist

8.3.1 General notes

A hoist with an absolute encoder is to be commissioned. Positioning is in increments of 1/10 mm. The total distance of travel is 2 m. The following data applies:

AGY 100 encoder:	4096 revolutions, 4096 pulses/revolution
Chain wheel diameter:	d = 273 mm
Measurements:	U = 857.655mm = 8576.55 x 1/10 mm ≈ 8577 x 1/10 mm
Gear ratio:	i = 45.37
Calculated parameters:	K10 = 4096 · i = 185836 K11 = 8577

The calculated parameters must be within the following ranges:

Ranges:	**K10**	**1 … 2^{31} - 1**	**= 1 … 2,147,483,647**
	K11	**1 … 2^{16} - 1**	**= 1 … 65,535**

The values do not therefore need to be reduced.

Positioning is subject to a position error because of imprecise figures for the gear ratio, the imprecise calculation of diameters and the rounding of the active wheel size:

$$\frac{K\ 10}{K11} = \frac{185836}{8577\ (rounded)} = 21.66783$$

$$\frac{K10}{K11} = \frac{185836}{8576.55\ (more\ precise)} = 21.66792$$

The systematic error in positioning is calculated as follows:

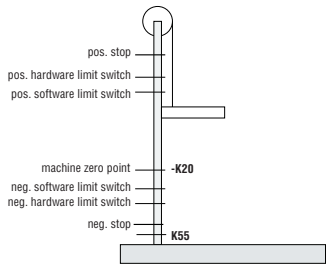
$$\frac{21.66792}{21.666783} = 1.000052477$$

corresponding to approx. 0.0052477 %

The maximum distance of travel is calculated in the APA 12 as

$$4{,}096\ \frac{\text{pulses}}{\text{rev.}} \cdot 4{,}096\ \text{rev.} \cdot \frac{8{,}577}{185{,}836} = 774{,}328\ \text{distance units (1/10 mm)}$$

8.3.2 Example 1: Encoder zero point outside of the working range



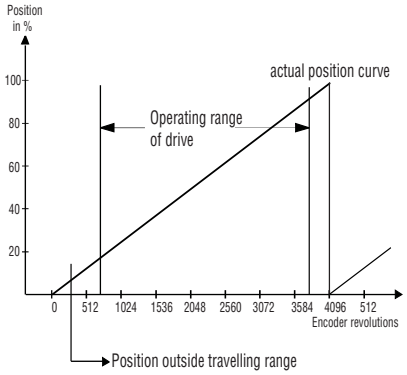


Fig. 65: MD0016EN MD0050EN

	Position display in 1/10mm	
	K20 = 0 K55 = 0 %rdssi	K20 = 712000 K55 = 704000 Position display =
positive stop	739000	27000
positive hardware limit switch	737000	25000
positive software limit switch	723000	11000
machine zero	712000	0
negative software limit switch	711000	-1000
negative hardware limit switch	710000	-2000
negative stop	708000	-4000
position outside travel range	704000	-8000

Assumed position below negative stop 704000

The following values are entered for K55 and K20:

K55 = 704000 (safety distance of 400 mm to negative stop)
K20 = -712000

- Save the data in the servo controller, then store the parameters to the flash EPROM via menu item *Programming - Store Data.*
  Switch the machine off and then on again. The initialization process is performed using the new parameter set.

This setting means that the machine zero is also the position zero. The negative hardware limit switch is displayed with the position -2000.

After adjustment, set parameters K21 and K22 (software limit switches) to the corresponding position - in the example:

K21 = 11000 and K22 = -1000

Saving the data completes the commissioning phase of the APA 12.

8.3.3 Example 2: Encoder zero point inside of the working range

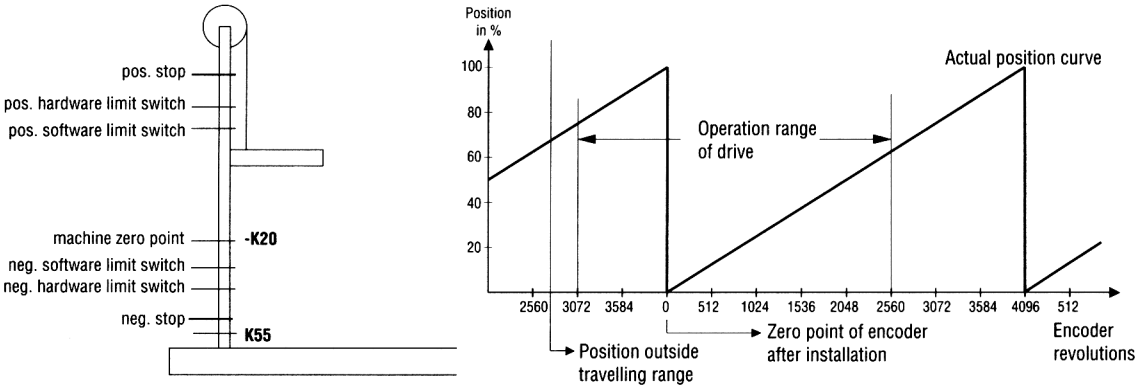


Fig. 66 MD0016AEN MD0051AEN

The hoist has the same structure as in Example 1, but the encoder zero lies within the working range because of where the encoder is installed.

K55 and K20 are set in two stages.

The following table contains the position details after each of the stages described below:

	Position display in 1/10 mm		
	Initial position	**Stage 1**	**Stage 2**
	K20 = 0 K55 = 0 %rdssi =	K20 = 0 K55 = 767200 %rdssi =	K20 = 775200 K55 = 767200 position display =
Positive stop	27871	802200	27000
Positive hardware limit switch	25871	800200	25000
Positive software limit switch	11871	786200	11000
Machine zero	871	775200	11000
Position step change reaches max. pos. (774328 1/10 mm) of encoder			
Negative software limit switch	774200	774200	-1000
Negative hardware limit switch	773200	773200	-2000
Negative stop	771200	771200	-4000
Position outside travel range	767200	767200	-8000

Assumed position below negative stop 767200

Description of the individual stages

Important: Carry out both stages in sequence

Stage 1

For K55, enter:

K55 = 767200 (safety distance of 400 mm to negative stop)

Save the data in the servo controller, then store the parameters to the flash-EPROM via menu item *Programming - Store Data*
Switch the machine off and then on again. The initialization process is performed using the new parameter set.

Stage 2

Now move the axis to the machine zero (=-zero offset)

For K20, enter:

K20 = -775200 **(machine zero with** negative **sign)**
(do not forget the negative sign)

- Save the data in the servo controller, then store the parameters to the flash-EPROM via menu item *Programming - Store Data.*
  Switch the machine off and then on again. The initialization process is performed using the new parameter set.

This setting means that the machine zero is also the position zero. The negative hardware limit switch is displayed with the position -2000.
After adjustment, set parameters K21 and K22 (software limit switches) to the corresponding position - in the example:

K21 = 11000 (positive software limit switch)
K22 = 1000 (negative software limit switch)

- Save the data in the servo controller, then save the parameters to the flash-EPROM via menu item *Programming - Store Data*
  Switch the machine off and then on again. The initialization process is performed using the new parameter set.

Saving the data completes the commissioning phase of the APA 12.

8.4 Positioning with the touch probe

8.4.1 Description of the touch probe

- The APA 12/API 12 has a high speed interrupt input with a response time of t = 100 µs. This input enables you to perform **relative** positioning operations starting at the time a signal is received at the touch probe input. The schematic below shows the sequence of events of such a touch probe positioning.

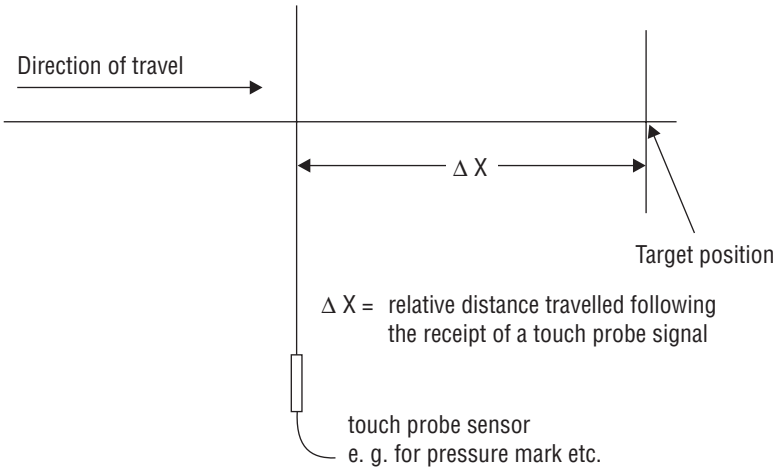

Direction of travel
Δ X
Target position
Δ X = relative distance travelled following the receipt of a touch probe signal
touch probe sensor
e. g. for pressure mark etc.

Fig. 67: Positioning with touch probe 00133AEN

When a touch probe signal is received, the instantaneous actual position is written to an internal variable. A subsequent touch probe command will start a positioning operation **relative** to the actual position stored in that variable. The relative distance travelled (Δ X) can be entered directly or via a variable value in the travel command (see section 7.3.2.4 Touch probe positioning commands).

Before reading the touch probe status via the program, the touch probe must be enabled either with the **SET TP** or **WAIT TP** commands.

8.4.2 Touch probe application examples

System description

A trolley shall travel from A to B. The trolley's target position shall depend on whether a signal is received at the touch probe input.

If the input is set, a certain mark along the travel distance has been overrun. From this point onward the system shall travel a distance of 1000 mm before the trolley is stopped.

Example:

```
% P01 (Touch probe example)
N010   GO0                    ; perform reference travel
N020   JMP (I010 = 0) N020    ; wait for enable
N030   GOA 10000 v 1000       ; perform absolute travel 10000 mm at v = 1000
mm/s
N040   WAIT TP                ; start touch probe logic and wait for
                                touch probe
N050   GOTPR 1000 v 1000      ; after touch probe travel X = 1000 mm at v =
1000 mm/s
N060   WAIT ST                ; wait until new relative position is reached
N070   JMP N020               ; Repeat loop
END
```

Note

The command **WAIT TP** can be replaced by the following command string:

```
       .
       .
       SET TP               ; activate touch probe logic
NXXX   JMP (TP = 0) NXXX    ; wait for touch probe
       .
       .
```

The above command string allows you to execute further commands while waiting for the touch probe, which is not possible when using the **WAIT TP** command. With the **WAIT TP** command program execution is suspended at the line number until the touch probe signal is received.

9 Technical Data

9.1 Input terminals

9.1.1 Mechanical design

– Terminals at 3.81 mm spacing
– 1 block with 11 terminals and 1 block with 7 terminals

9.1.2 Electrical specifications

- Digital inputs

  The inputs conform to DIN 19240 specifications (PLC process and data interface).

  Guaranteed working range (minimum):
  1 signal: 13 ... 30.2 V
  0 signal: -3 V ... 5 V
  typical: 24 V / 6 mA

  Delay time 1 ... 5 ms; Touch probe: 20 ... 100 µs

  Input specification:

  – Reverse voltage protection
  – Input filter
  – Power losses optimized to max. 1/4 W per channel
  – Isolation via optocouplers

- Voltage input 24 V

  to supply binary outputs + 24 V (A)

9.2 Output terminals

9.2.1 Mechanical design

– Terminals at 3.81mm spacing
– 1 block with 10 terminals

9.2.2 Electrical specifications

- Digital outputs

  The 8 outputs (operating voltage: 24 V) having the following specifications:

  – Short-circuit-proof
  – Thermal protection
  – Isolation via optocouplers
  – Fault signal in the event of:
    – Ground fault
    – Thermal overload
    – Undervoltage (min. 9 V)

The data below are per output

- Output current:
  - ohmic load 500 mA
  - inductive load 12 W
  - lamp load 250 mA
  - capacitive load 2 µF
  - power loss max. 250 mW (approx. 0.7 Ω x source current)

- Voltage output 24 V

  for the supply of the binary inputs and outputs + 24 V

9.3 Encoder connection

Encoders with internal voltage bias are used. Absolute encoders may be supplied via terminals X11/38 ... 39 (15 V) (maximum supply curent: 240 mA).

9.3.1 Mechanical design

- Terminals at 3.81 mm spacing
- 1 block with 8 terminals

9.3.2 Electrical specifications

The encoder interface is designed in differential technology for incremental encoders. The use of voltage dividers at channels $\overline{A}$, $\overline{B}$ and $\overline{C}$ also allows for the connection of unipolar encoders as well.

Technical Data

Leads terminated:	- 120 Ω serial with 1 nF - dynamic 120 Ω - static high resistance
Input circuit elements:	- failsafe circuits - 4.7 kΩ pullup at channels A, B, 0 - voltage dividers with 4.7 kΩ each at channels $\overline{A}$, $\overline{B}$, $\overline{C}$
Switching hysteresis:	approx. 50 mV
Differential voltage:	min. 1V, max. 15V between A and $\overline{A}$, B and $\overline{B}$, C and $\overline{C}$
Internal counting frequency:	max. 750 kHz
Input signal frequency:	max. 187.5 kHz

9.4 CAN connection

9.4.1 Mechanical design

– Terminals at 3.81 mm design
– 1 block with 3 terminals

9.4.2 Electrical specifications

– Transmission rate 500 kbits/s
– Outputs **not** short-circuit-proof!

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